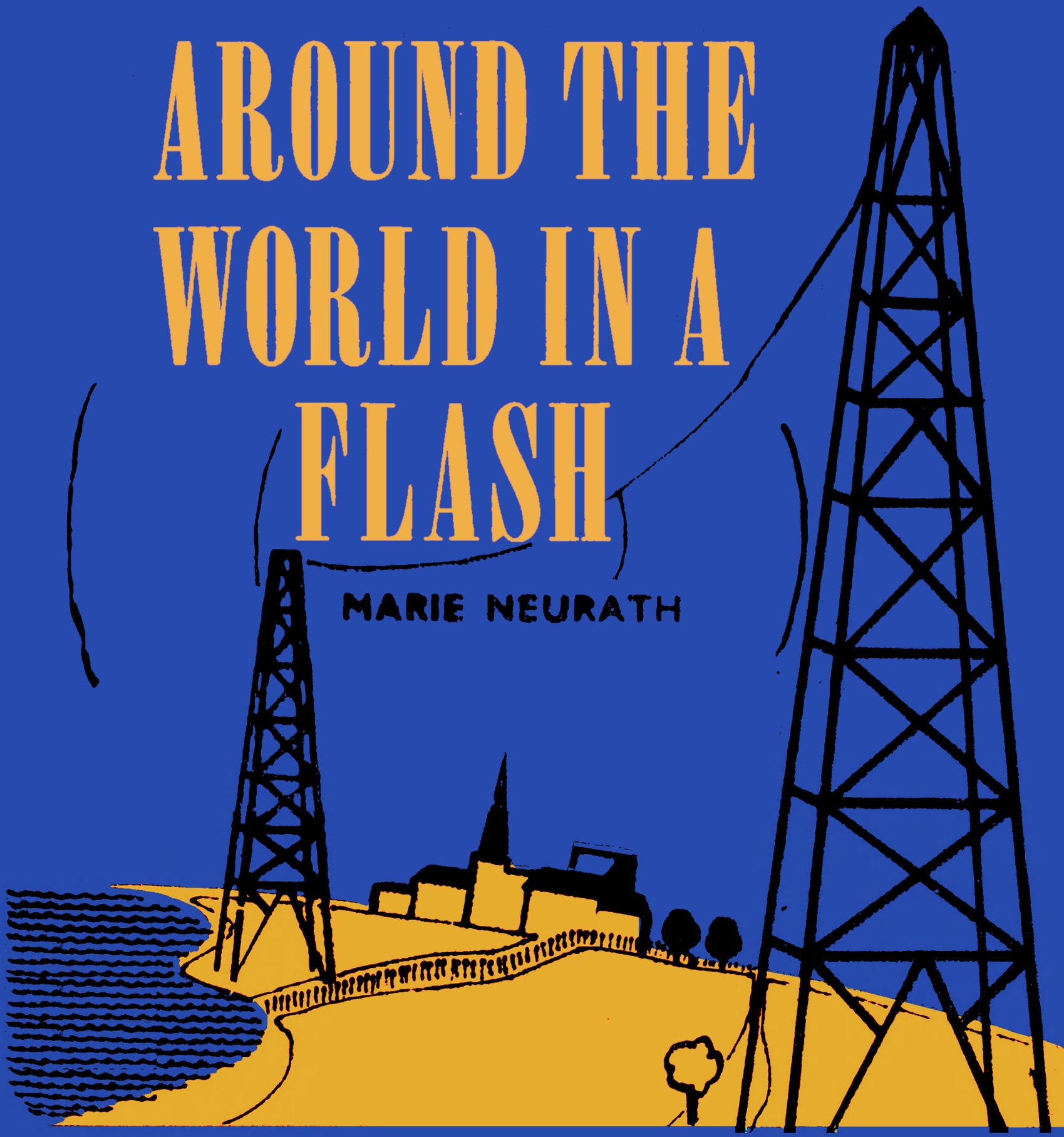
AROUND THE WORLD IN A FLASH

MARIE NEURATH



AROUND THE WORLD IN A FLASH

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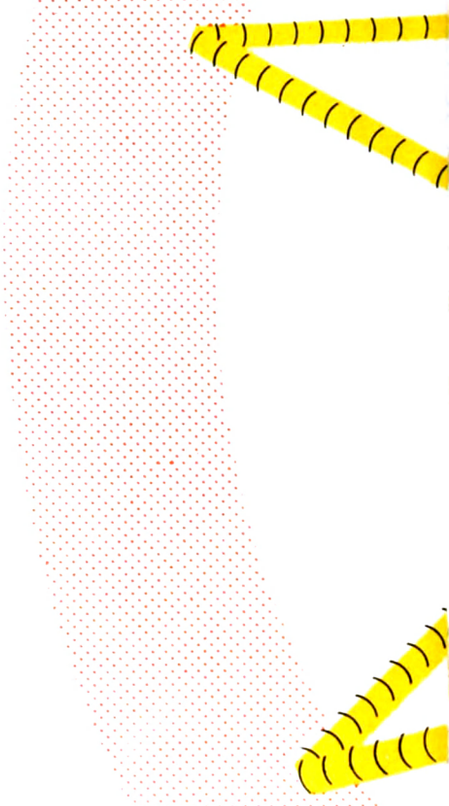
HOW MESSAGES ARE SENT

Marie Neurath



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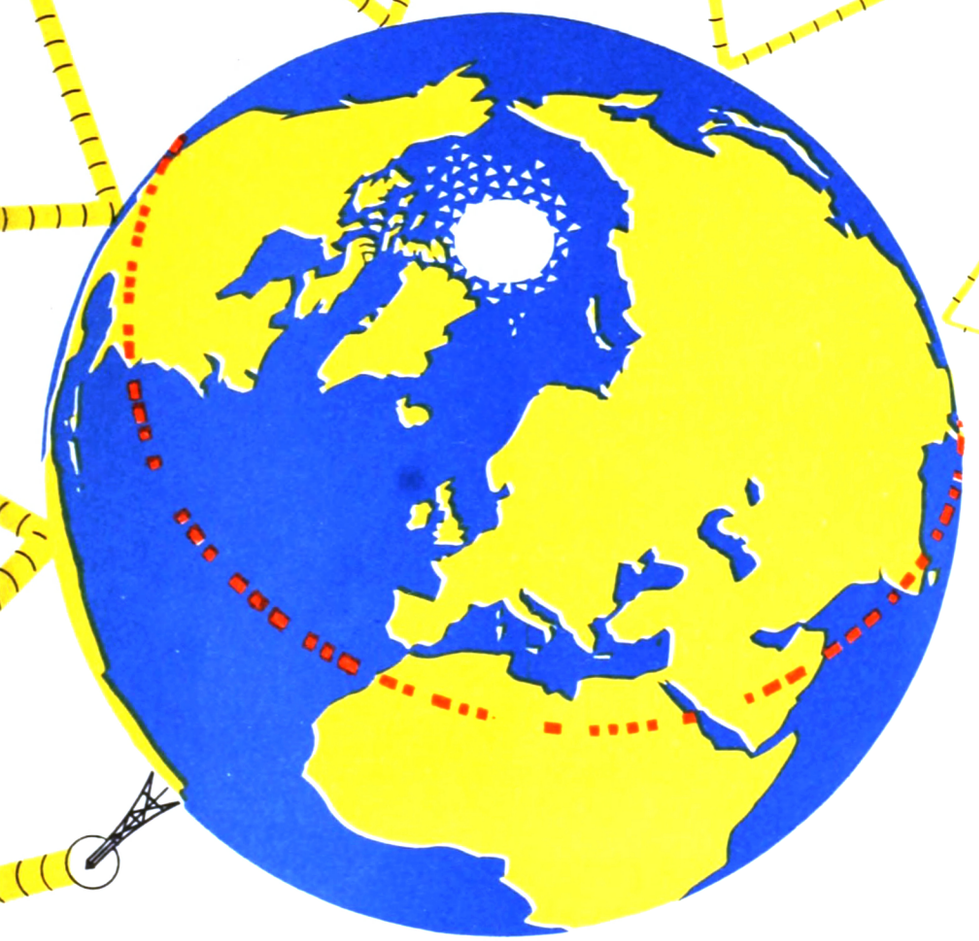
ORLD IN A FLASH

PHONE, TELEGRAPH, RADIO AND TELEVISION



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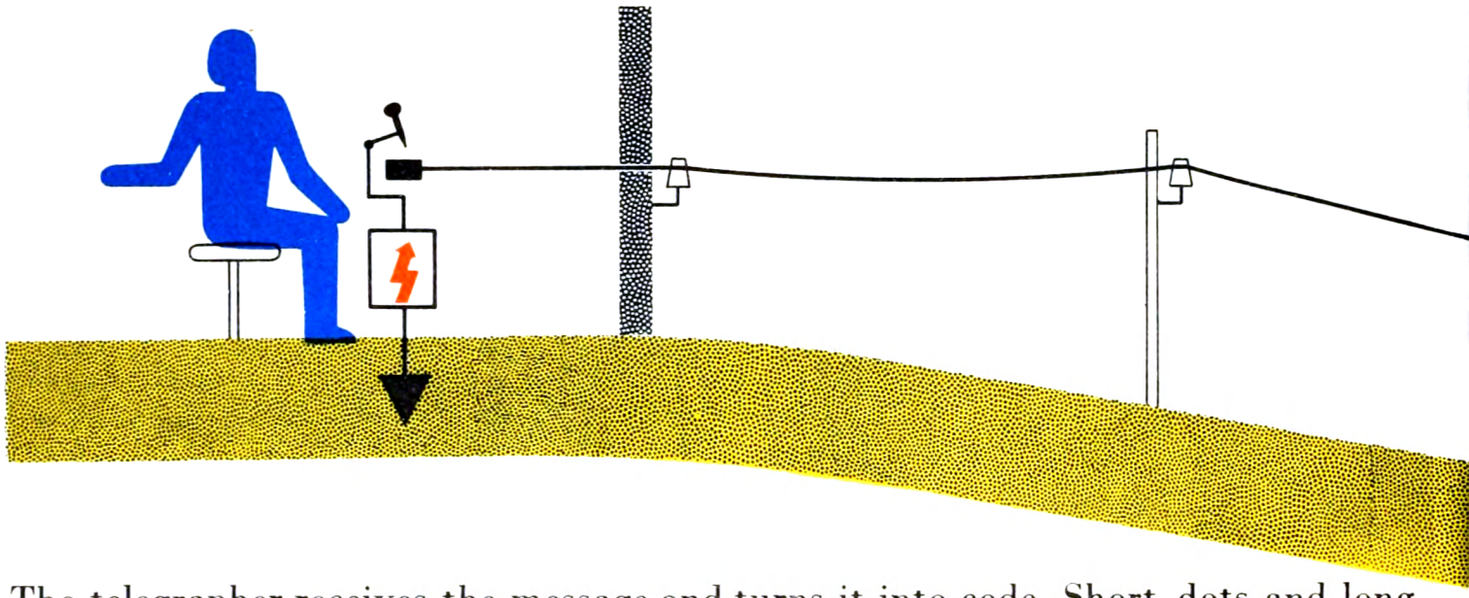
We are grateful to the engineers of Cable & Wireless Limited for their collaboration in preparing the text and pictures of this book.

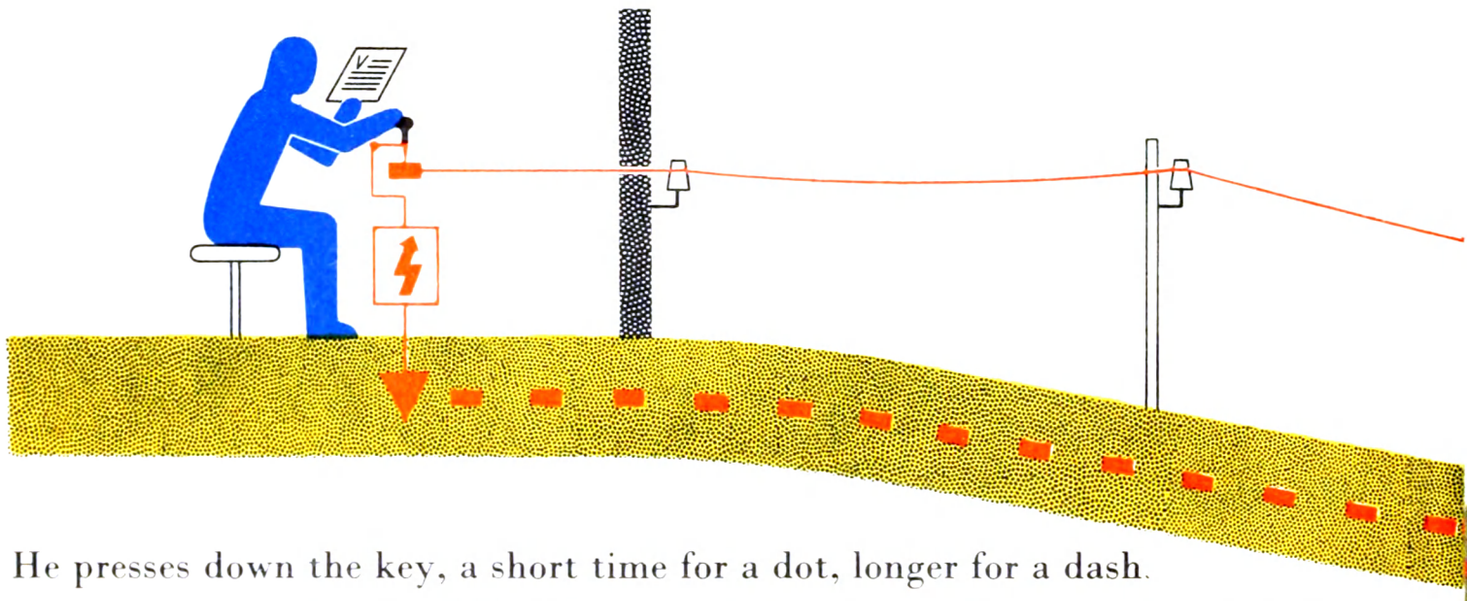
News that the World will Want to Hear

For years this volcano has been silent. Suddenly there is a rumbling and a burst of flame. Boiling lava pours down its slopes, setting fire to house after house. Two fast runners dash to the nearest telegraph office. Their village needs help, and the world wants to hear their news.

A Key is Tapped, a Current Flows, th

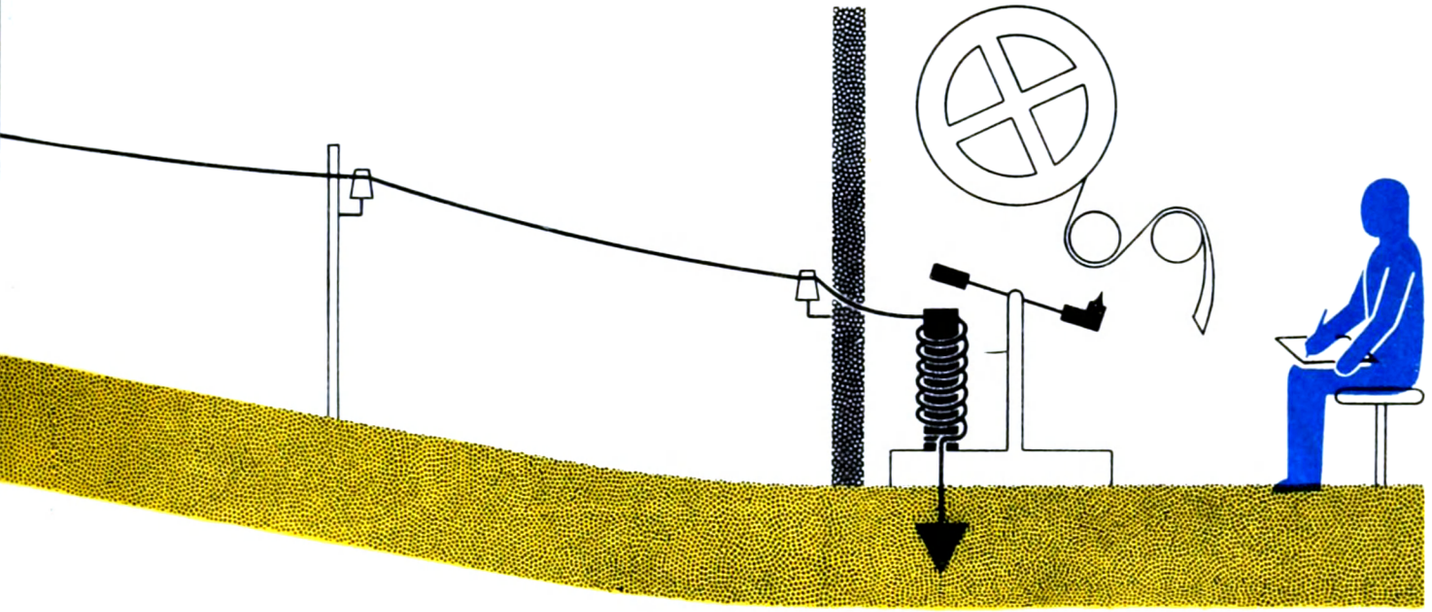


The telegrapher receives the message and turns it into code. Short dots and long dashes represent the letters of the words.

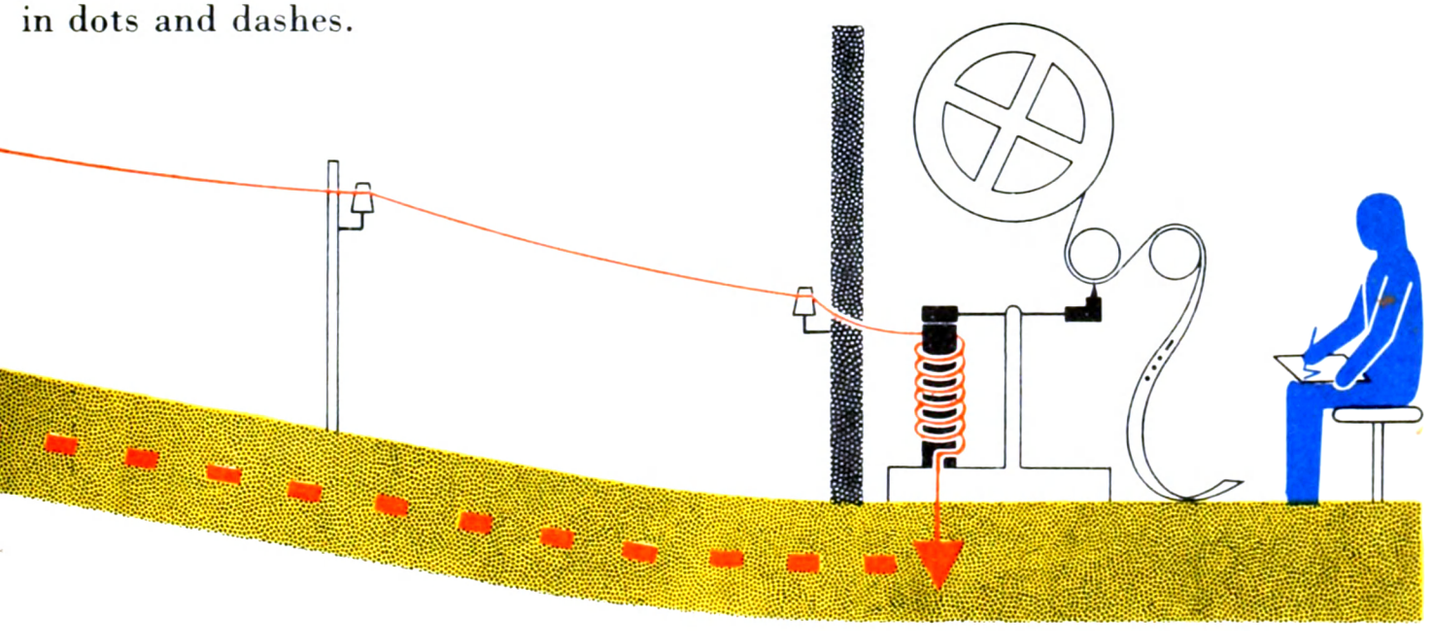


He presses down the key, a short time for a dot, longer for a dash.
When the key is down, an electric current flows along the wire; when it is up, no current flows. Many miles away the current causes a magnet to attract a lever, a short time for a dot, longer for a dash.

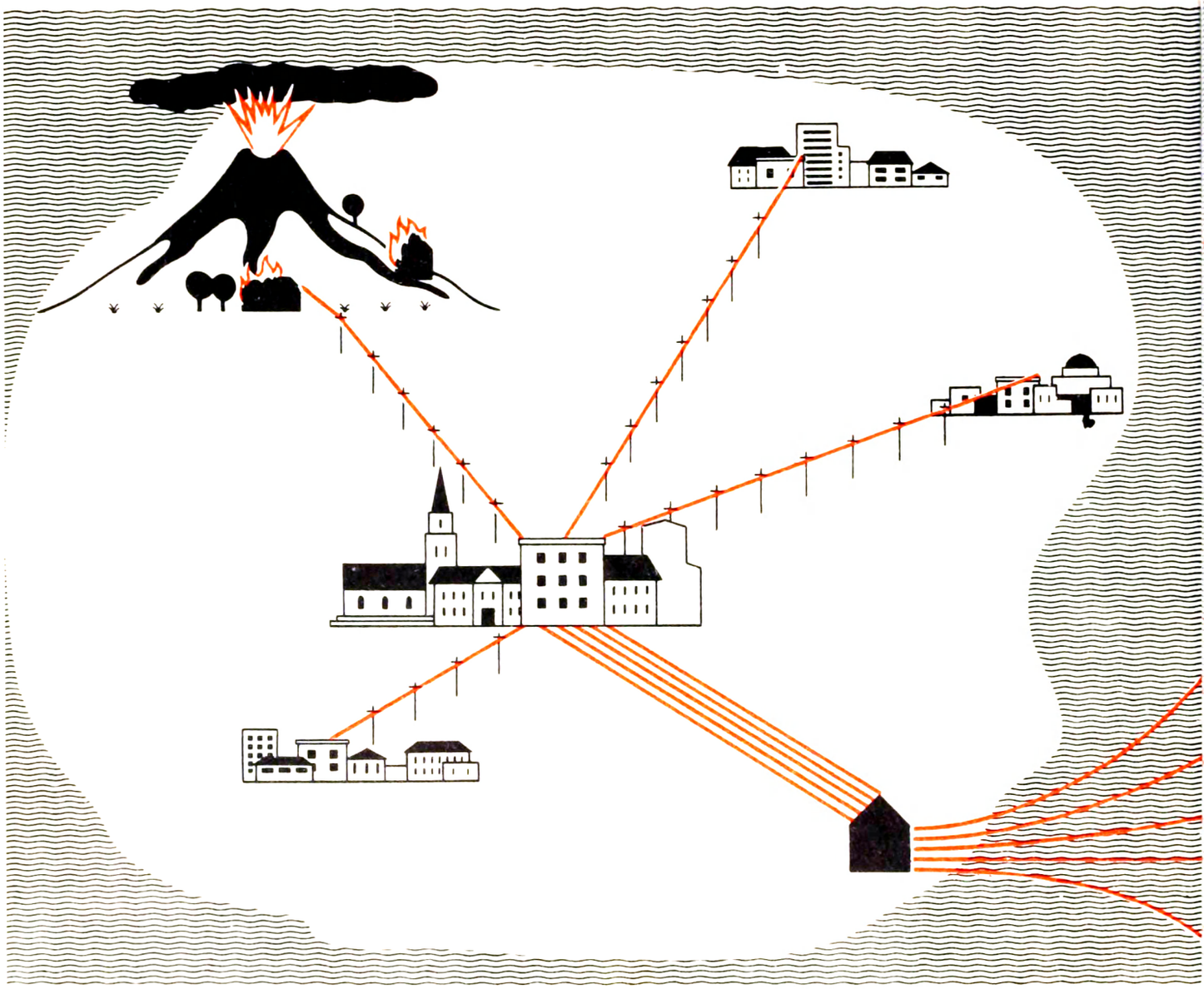
ws Travels



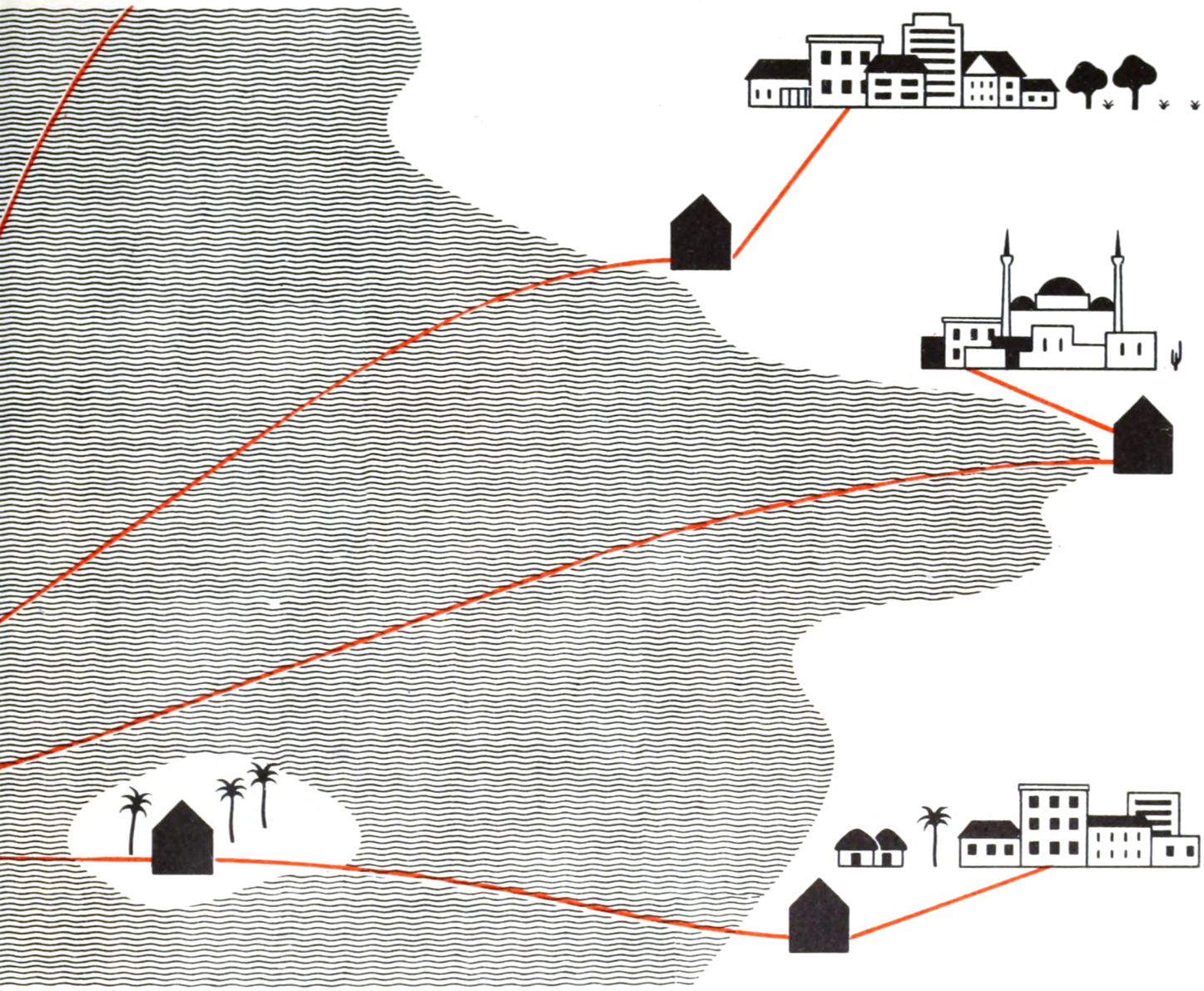
The pointer on the lever marks a moving strip of paper and the message appears in dots and dashes.



The Wires which Stretch Across the World

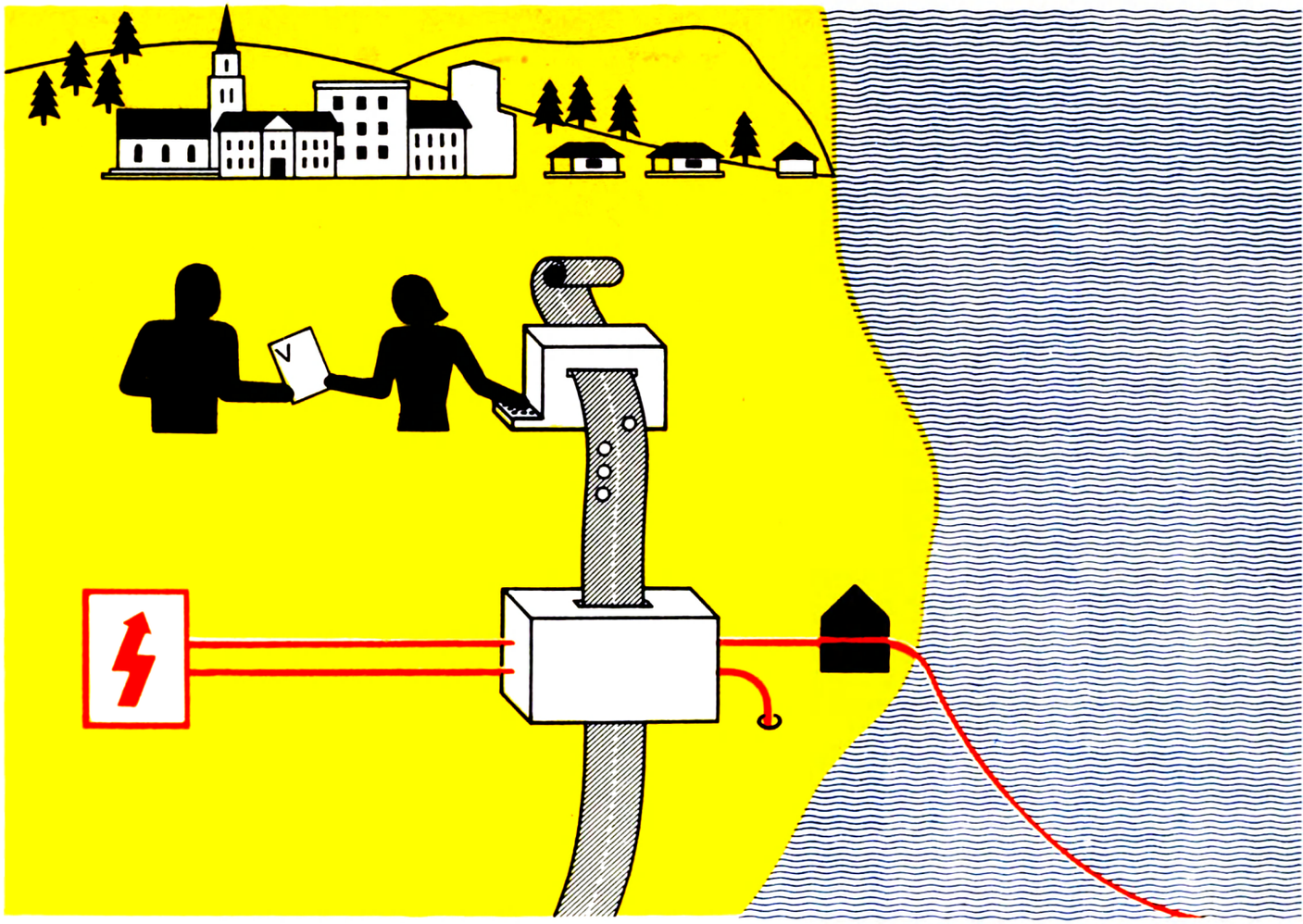


One wire is not enough to carry the news to all parts of the world. It is carried first to a central office. There it is tapped out again and again. Telegraph wires carry it overland to other towns and cities. Underground wires take it to the cable-house on the coast.

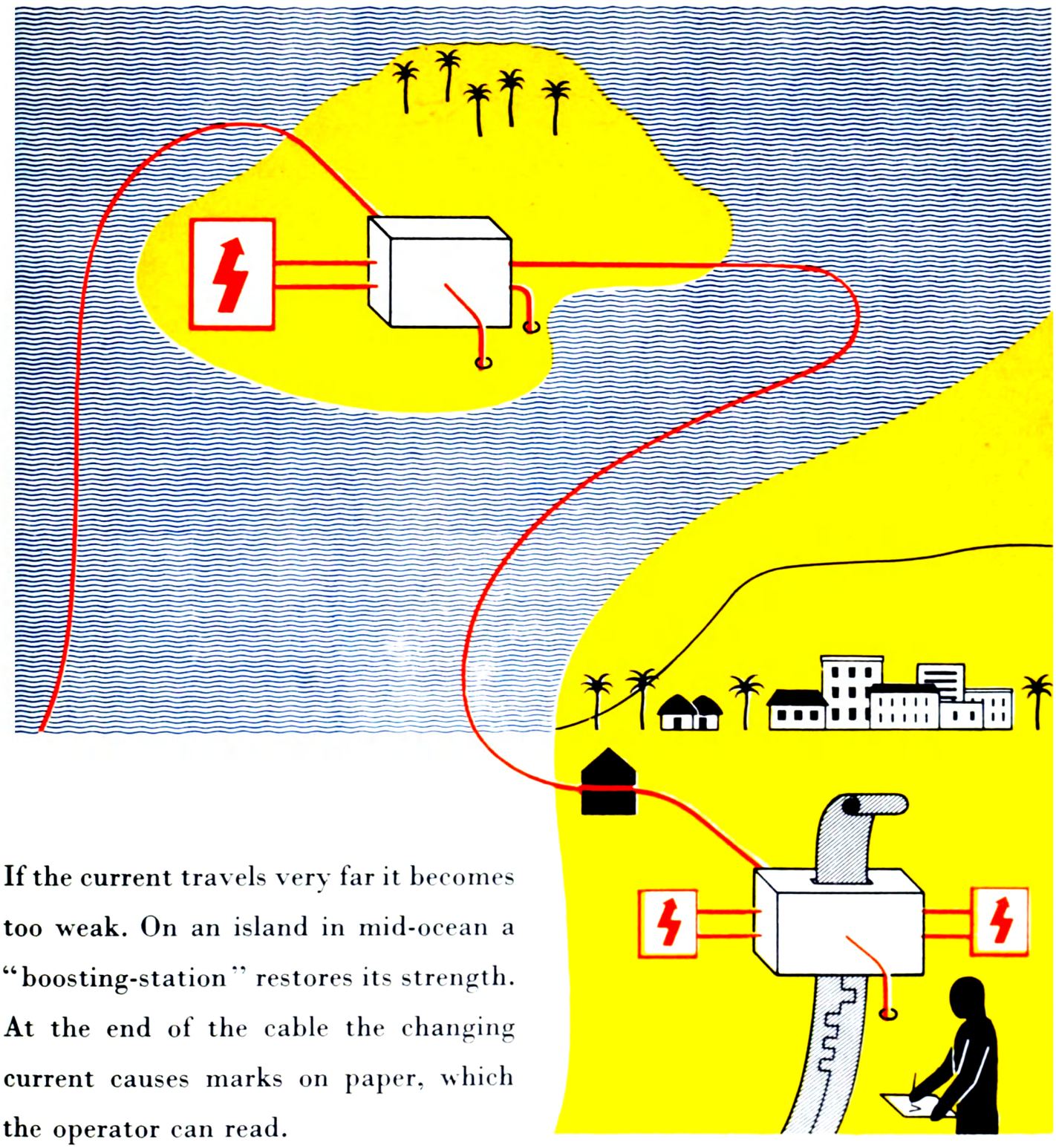


From the cable-house, cables stretch out on the bed of the ocean to other cable-houses in many lands. Underground wires carry the message from these cable-houses to the large cities near by. In these cities the news will be printed in the newspapers within a few hours.

A Message by Cable Under the Sea

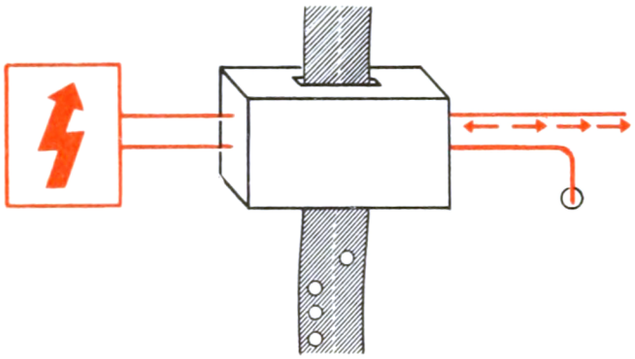


At the central office, a girl types out the message. But when she presses a key, instead of printing a letter, it punches holes in a moving strip of paper. Holes on the left mean dots, holes on the right dashes, and these are arranged differently for each letter. Then the strip passes into the sending machine. When we turn over we shall see how the holes cause a current to pass first one way and then the other through many miles of cable, to the receiving station.

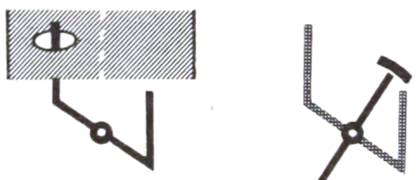


If the current travels very far it becomes too weak. On an island in mid-ocean a "boosting-station" restores its strength. At the end of the cable the changing current causes marks on paper, which the operator can read.

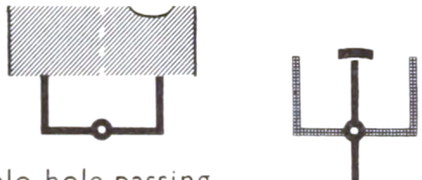
The Wonderful Machines which Send a



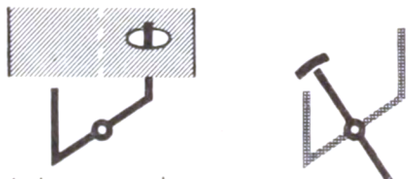
Inside the sending machine is a lever with two upright arms. As a dot-hole in the paper strip passes over, one arm presses through it; as a dash-hole passes over, the other arm presses up. As the lever moves up and down it turns a switch. This allows a current to pass first one way and then the other through the cable.



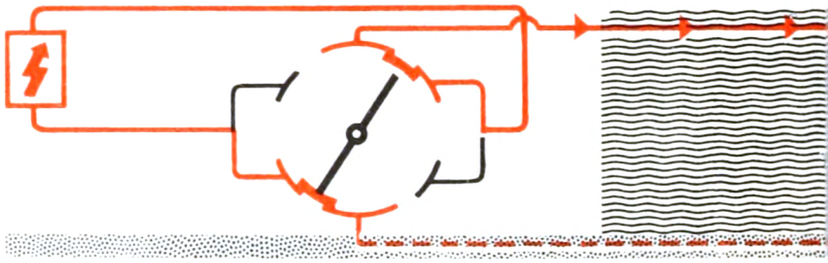
Hole on left passing

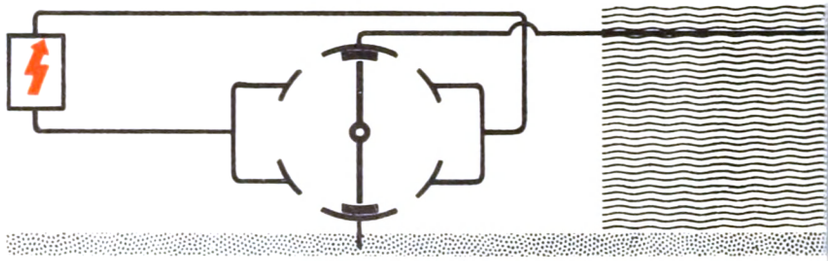


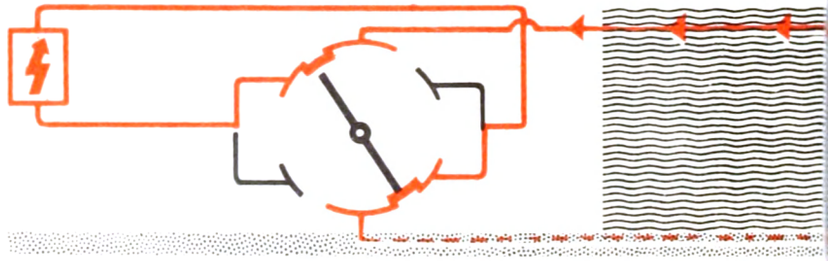
No hole passing



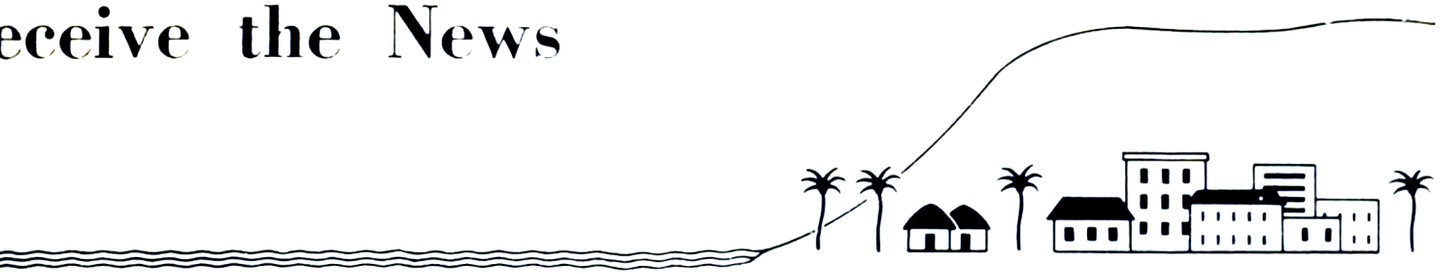
Hole on right passing





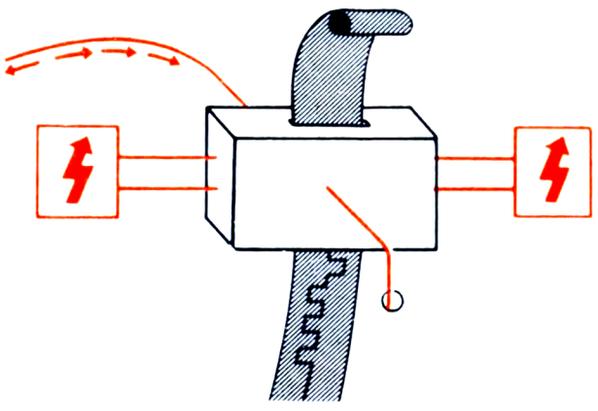


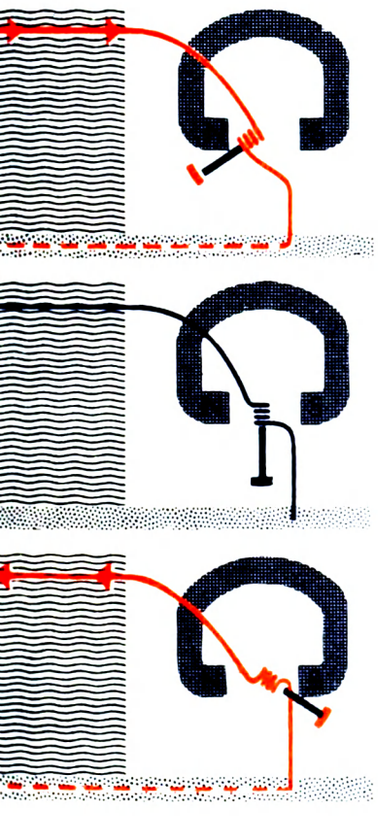
eceive the News

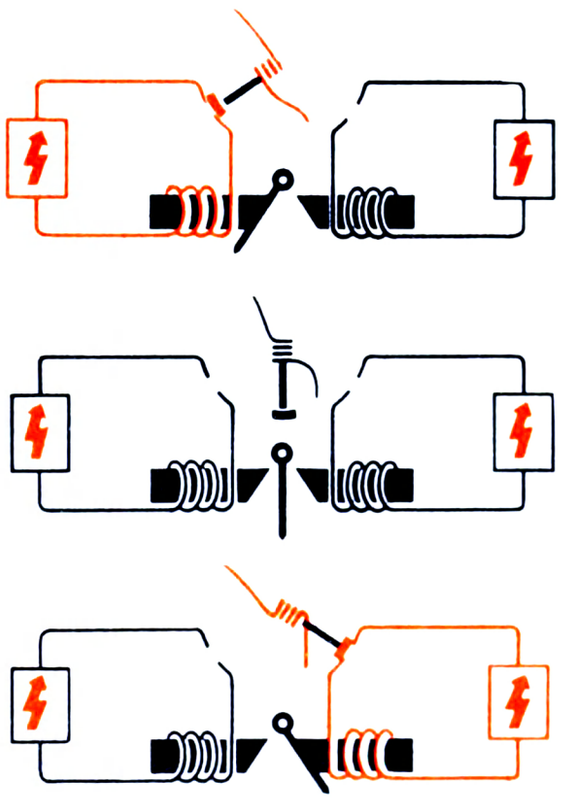


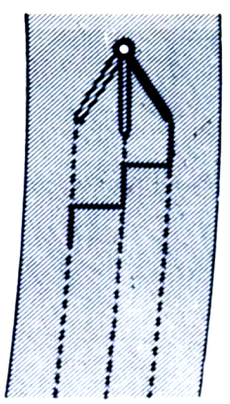
At the other end, the current pulls a switch, first one way and then the other. This allows new currents to flow, which in turn start magnets, pulling a metal pen to left or right.

The pen marks form a pattern on a moving strip; a line on the left means a dot, one on the right a dash.

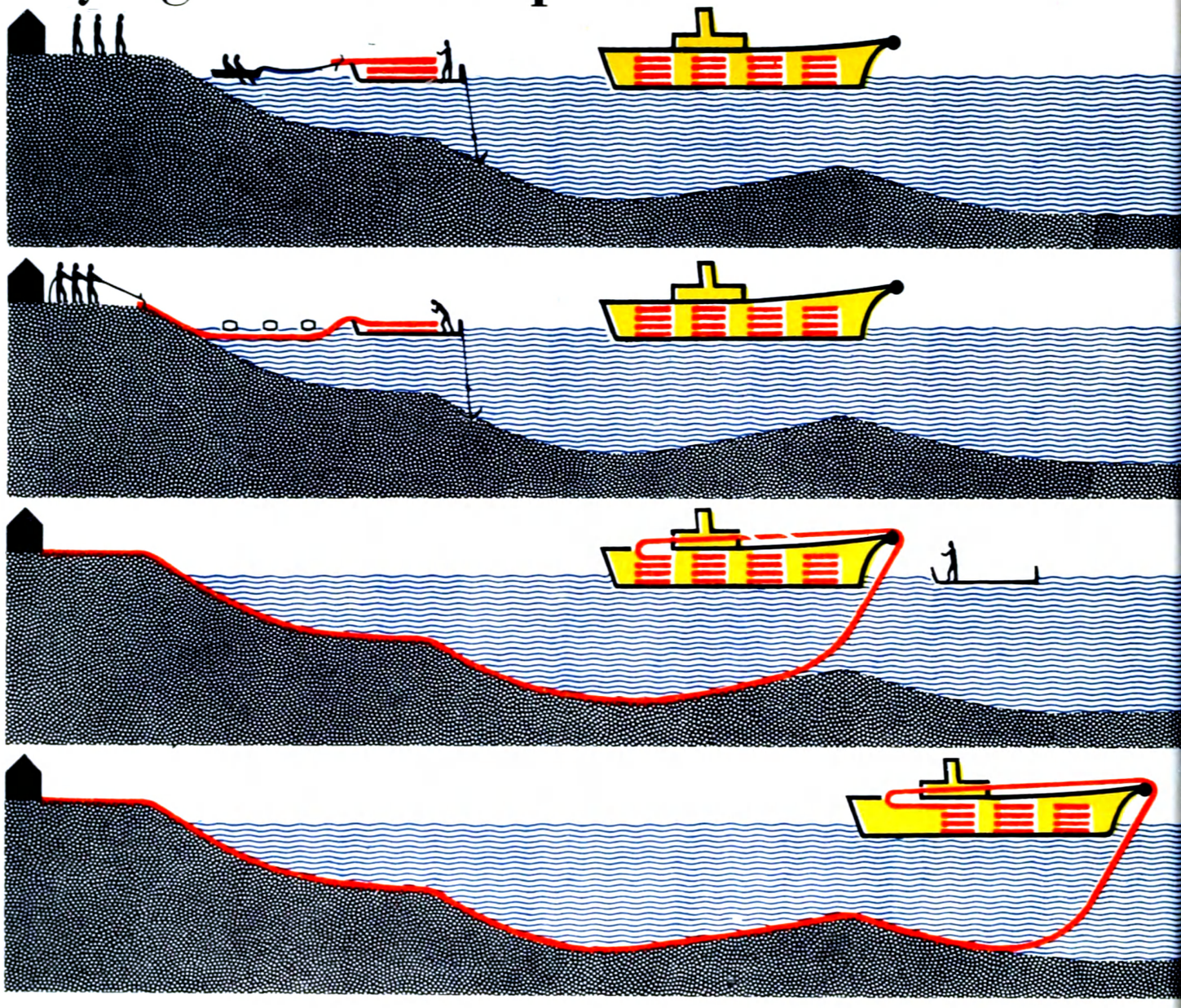


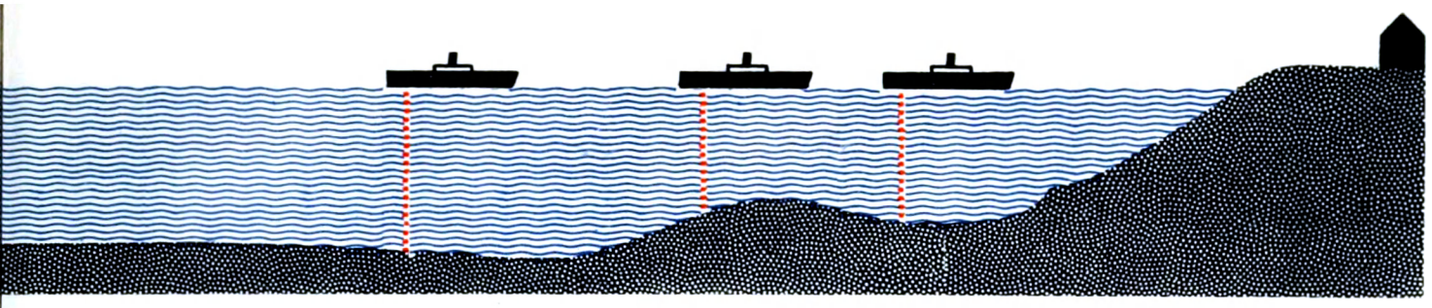






Laying a Cable Deep on the Sea-bed



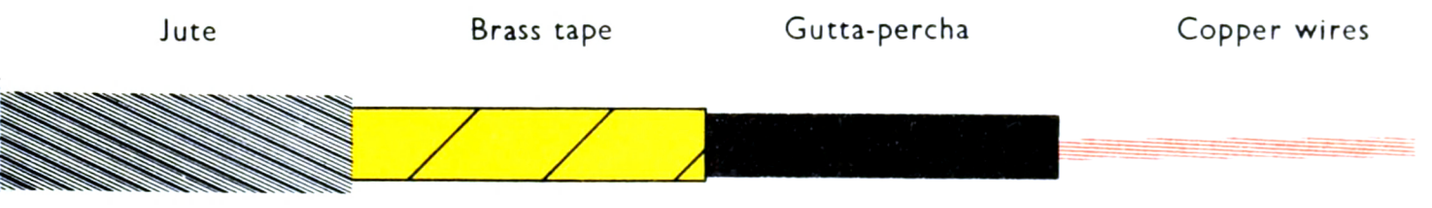


If an under-sea cable is laid where there are sharp, rocky slopes, it will soon wear through and break. Before laying begins, ships go out to test the sea-bed and measure the depth of water along the route.

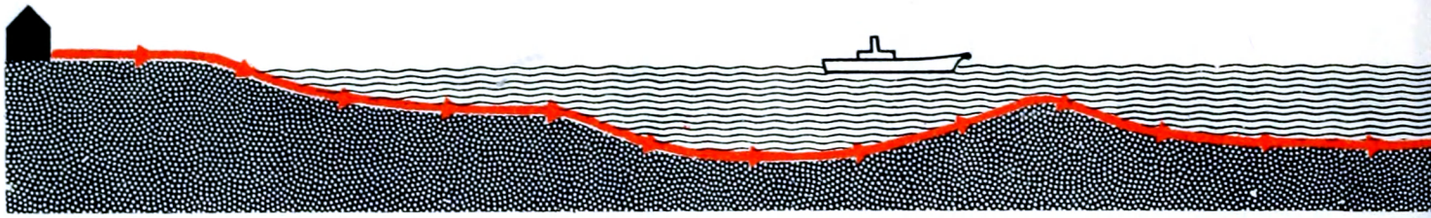
The cable-laying ship is too big to sail in the shallow water near the coast, so the first length is laid by a small boat anchored just off shore. One end of the cable, held up by empty barrels, is floated towards the beach, hauled ashore and connected up to the cable-house. The boat then goes alongside the big cable-layer where the other end is taken aboard.

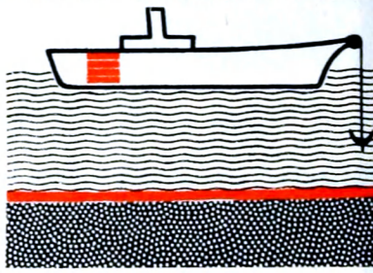
The cable-layer carries many miles of cable coiled in huge circular tanks. As it steams along, mile after mile of cable is paid out, sometimes over the bows, sometimes over the stern, and drops to the bed of the sea.

The diagrams below show how the cable is made. Through the center run the copper wires which carry the current. Round them are layers of many different materials to strengthen and protect them, and to prevent the current leaking.



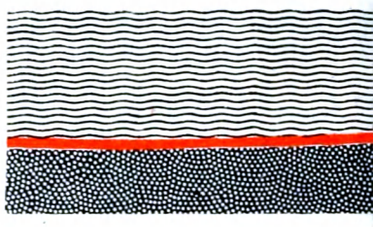
When a Cable Breaks, Out in the Ocean

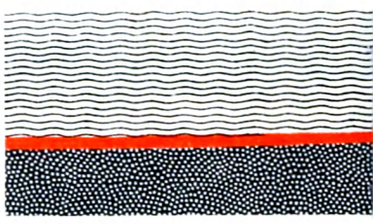


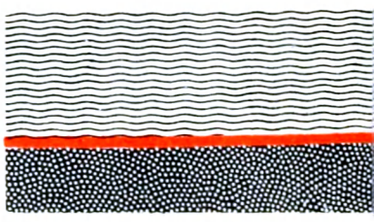


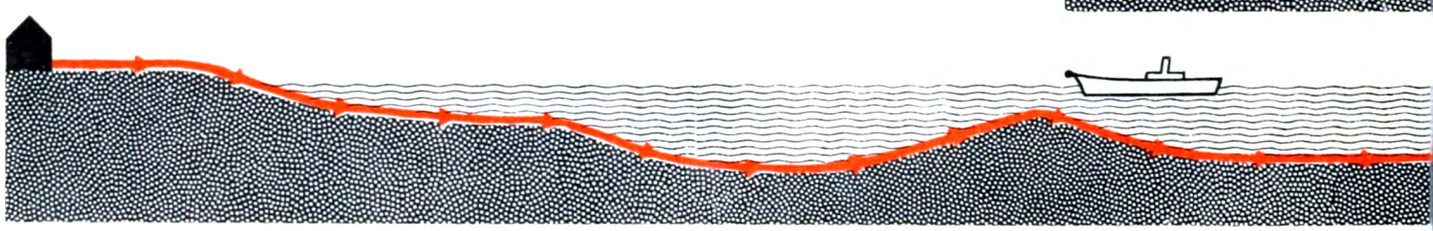
Sometimes a cable breaks a mile under the sea and a thousand miles from land. How is the break to be found? Every cable resists the flow of electricity – the longer the cable, and the thinner the copper wire, the greater the resistance. The resistance of the cable, mile by mile, is already known ; so by means of special instruments the engineers now measure the resistance up to the point where the cable is broken. This tells them how far it is from the cable-house to the break.

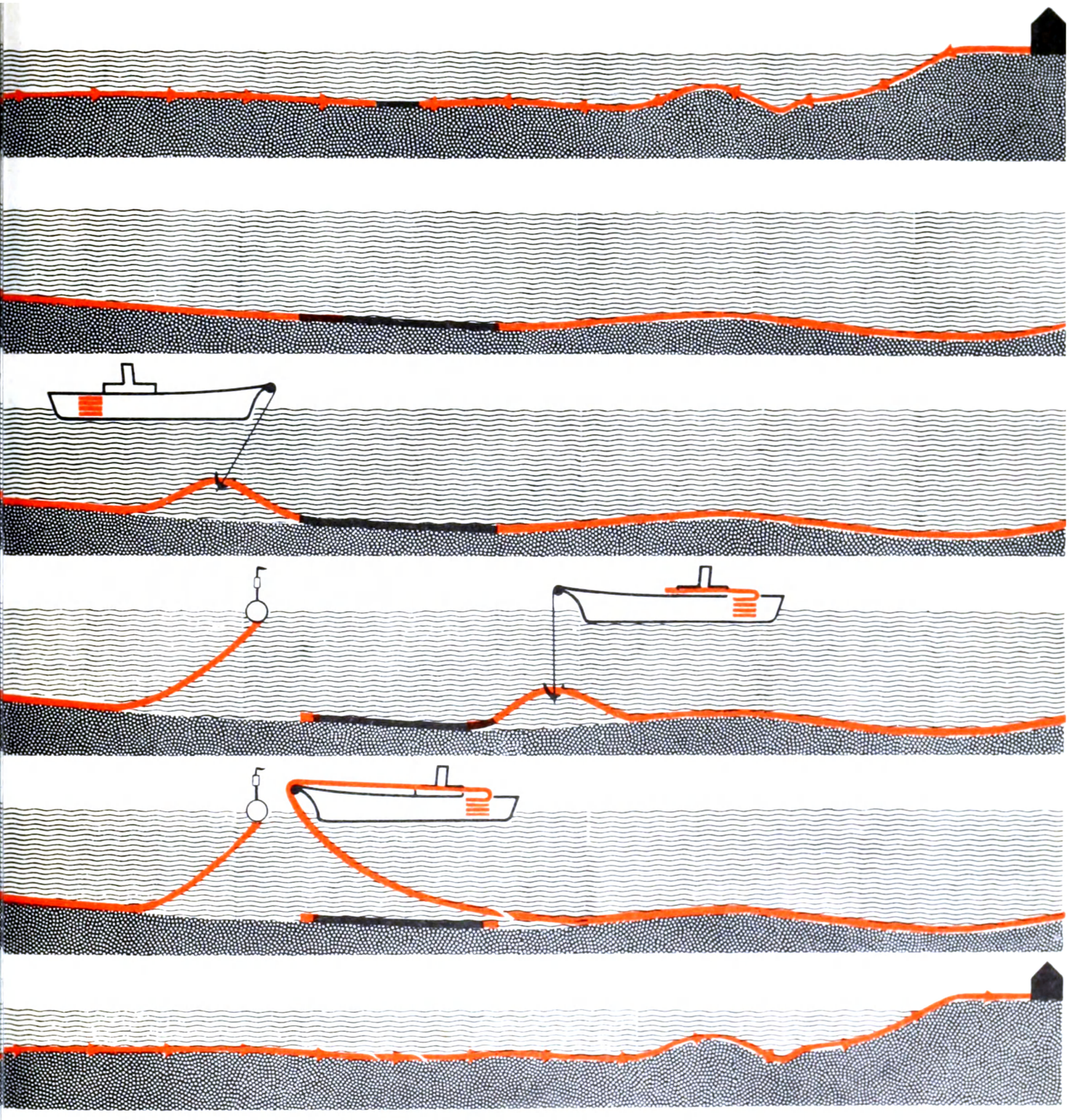
A repair ship steams to the spot and drags a strong hook, called a grapnel, along the sea-bed. When the grapnel catches under the cable, the first broken end is raised out of the water and held up with a buoy. The other end is raised in the same way, then the two are joined together Soon messages are flashing under the ocean again.



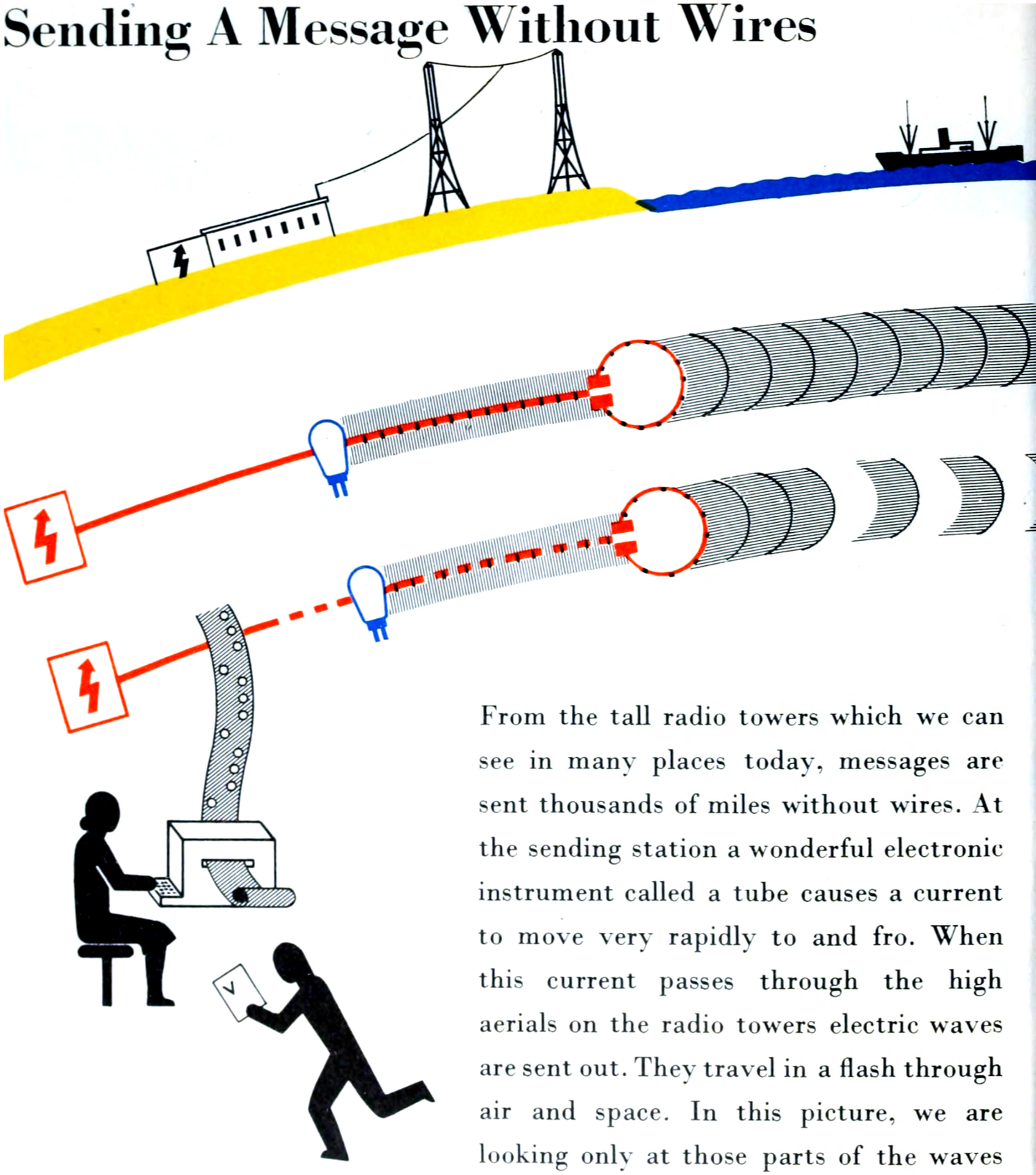




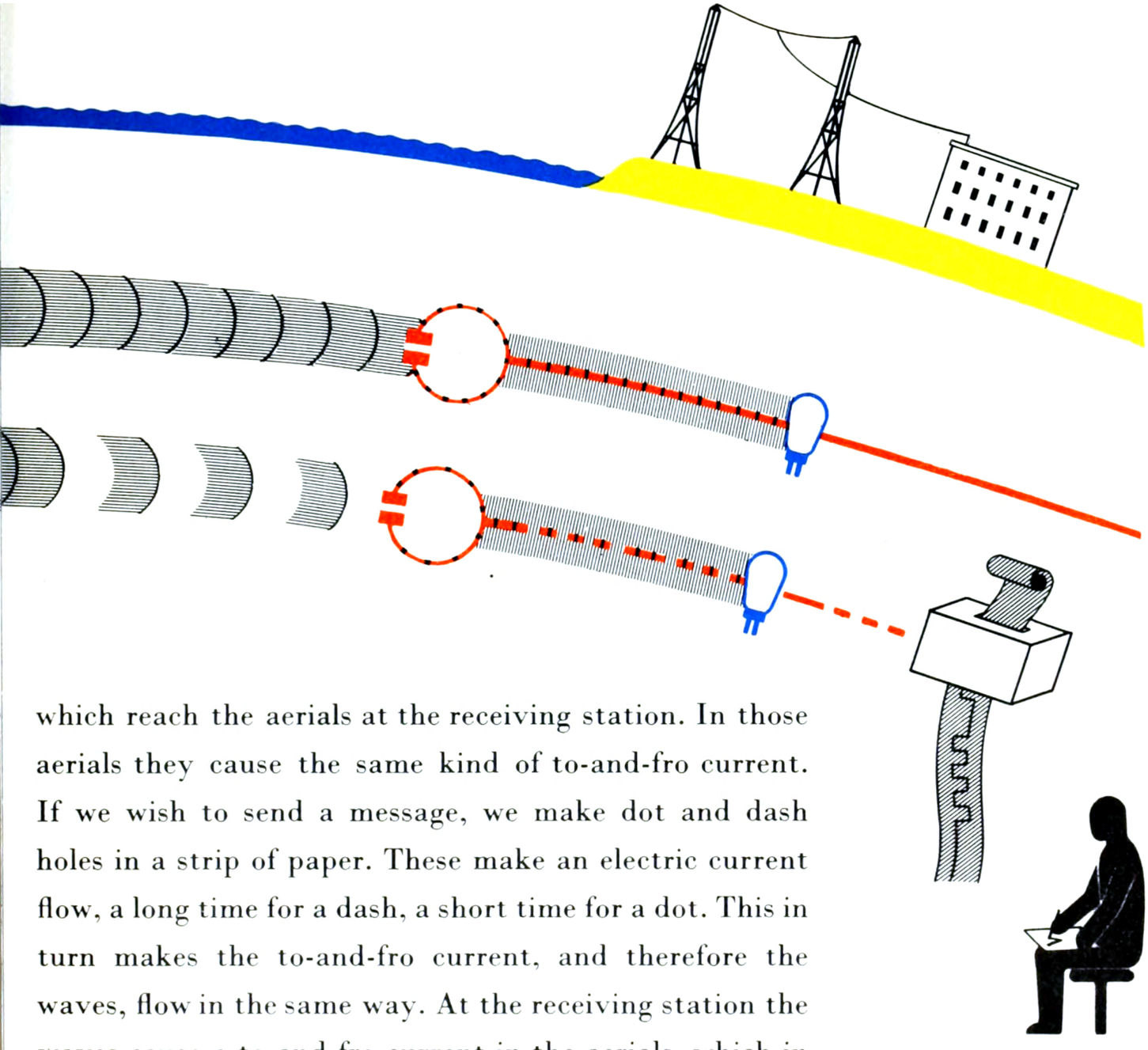




Sending A Message Without Wires

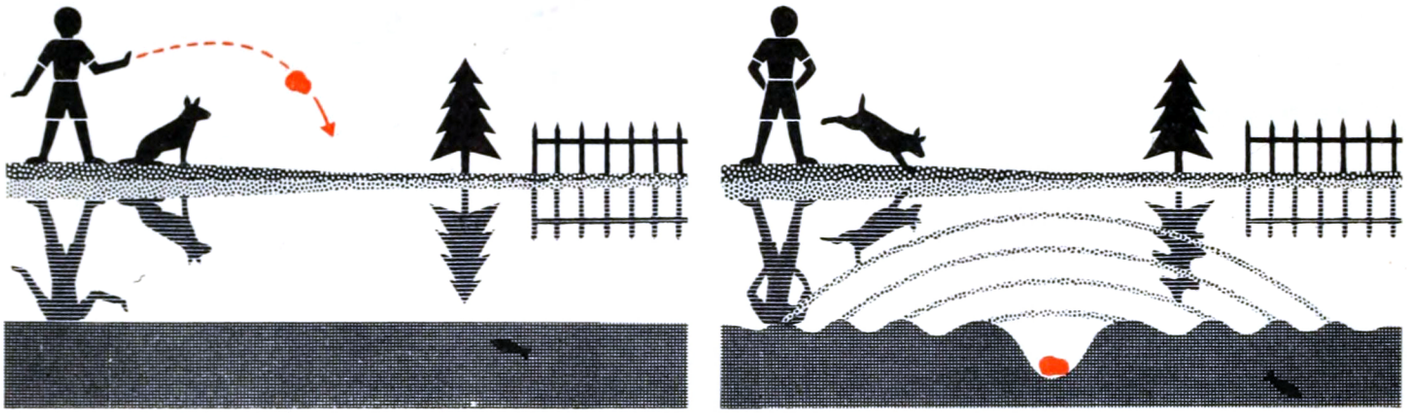


From the tall radio towers which we can see in many places today, messages are sent thousands of miles without wires. At the sending station a wonderful electronic instrument called a tube causes a current to move very rapidly to and fro. When this current passes through the high aerials on the radio towers electric waves are sent out. They travel in a flash through air and space. In this picture, we are looking only at those parts of the waves



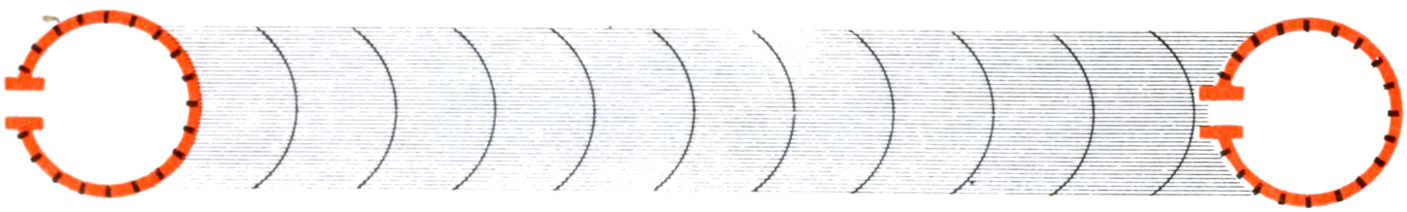
which reach the aerials at the receiving station. In those aerials they cause the same kind of to-and-fro current. If we wish to send a message, we make dot and dash holes in a strip of paper. These make an electric current flow, a long time for a dash, a short time for a dot. This in turn makes the to-and-fro current, and therefore the waves, flow in the same way. At the receiving station the waves cause a to-and-fro current in the aerials, which in turn causes a simple current to move a pen on paper; it writes a long line for a dash, a short one for a dot, with a swing to the other side in between.

The Waves which Travel the World in

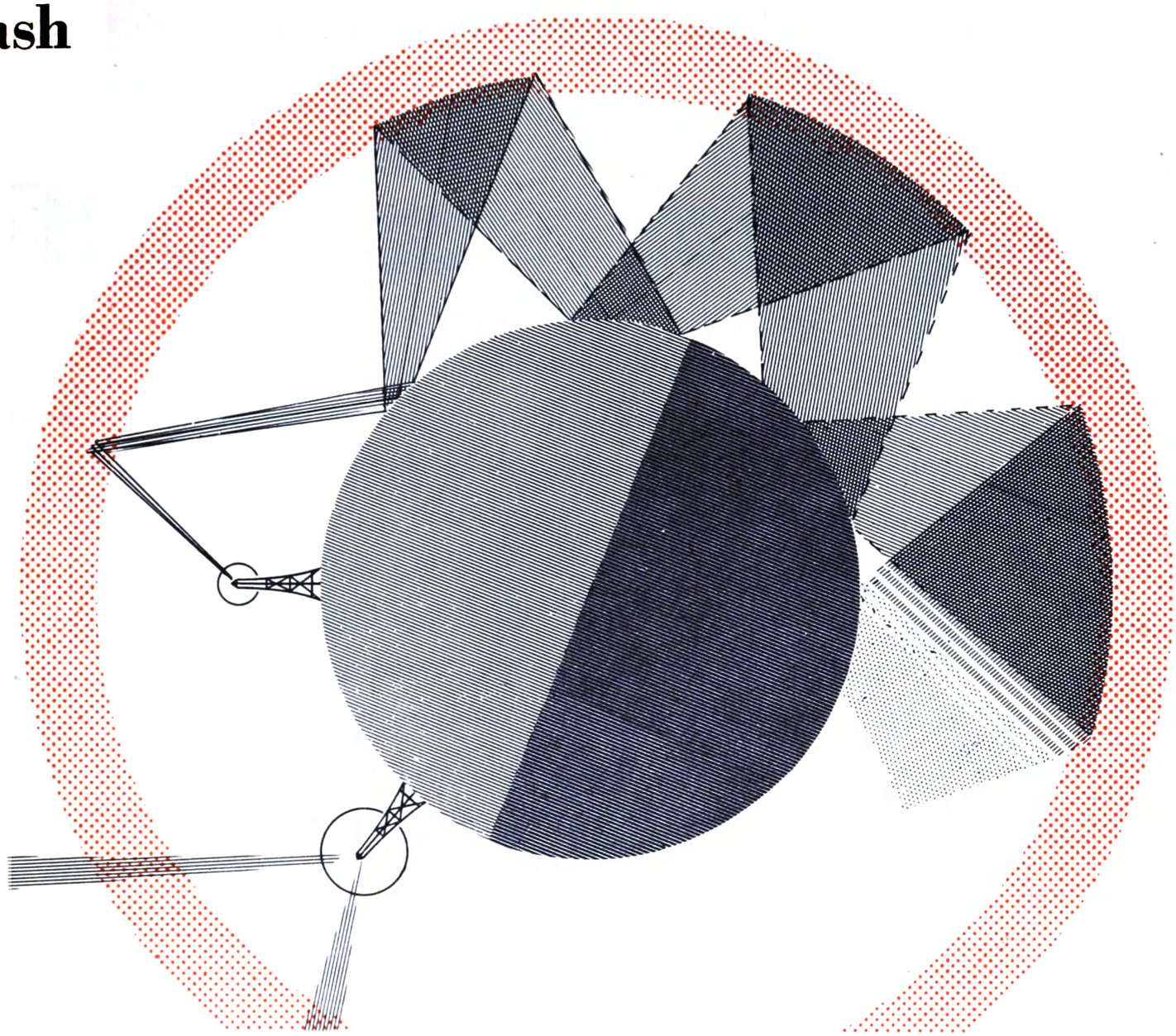


To make waves on a pond, we must set the water moving up and down. It is this up-and-down motion which moves across the pond, not the water itself. To make sound waves, we must set the air vibrating to and fro, as we do when we ring a bell. This to-and-fro vibration moves through the air.

Movement is also needed to produce the electric waves which travel through space as fast as light. That is why a current must be used which moves rapidly to and fro in the aerial.

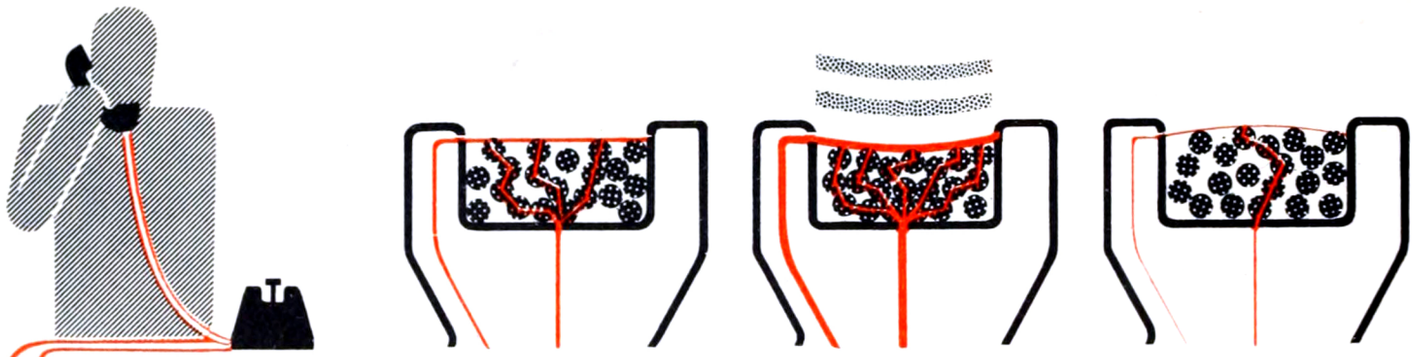


lash



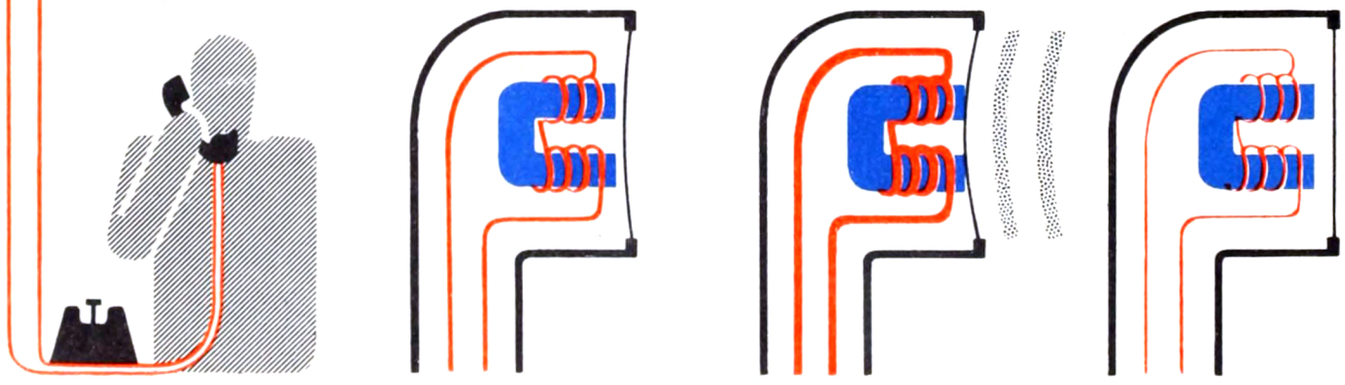
We can make electric waves longer or shorter by varying the rate of this to-and-fro movement. To send a message a very great distance, rather short waves are used. They travel up to a region beyond the earth's atmosphere which contains millions of particles charged with electricity, and are reflected to and fro between this region and the earth. Long waves, or *very* short waves, would not be reflected back from this region.

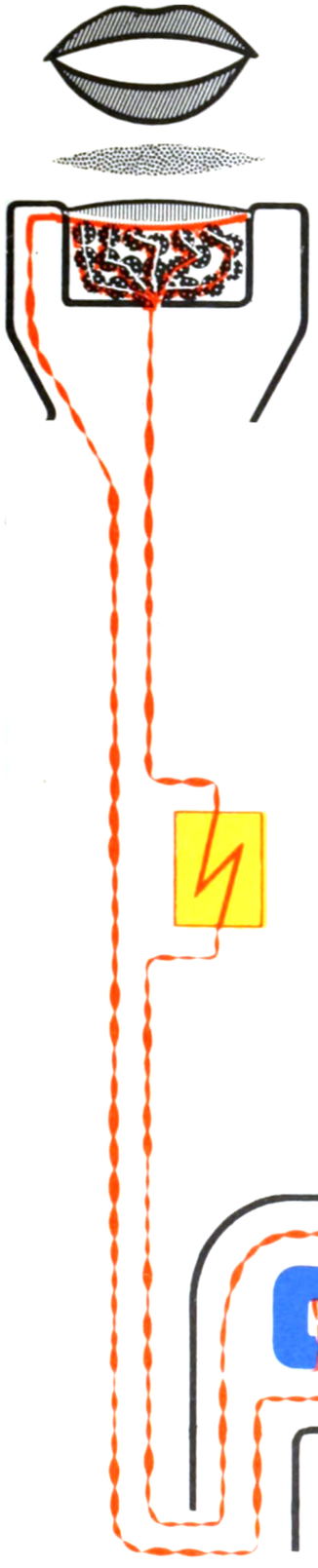
The Current that Carries a Voice



We have already seen how a message of dots and dashes is carried along a telegraph wire. Here we shall see how a voice is carried along a telephone wire.

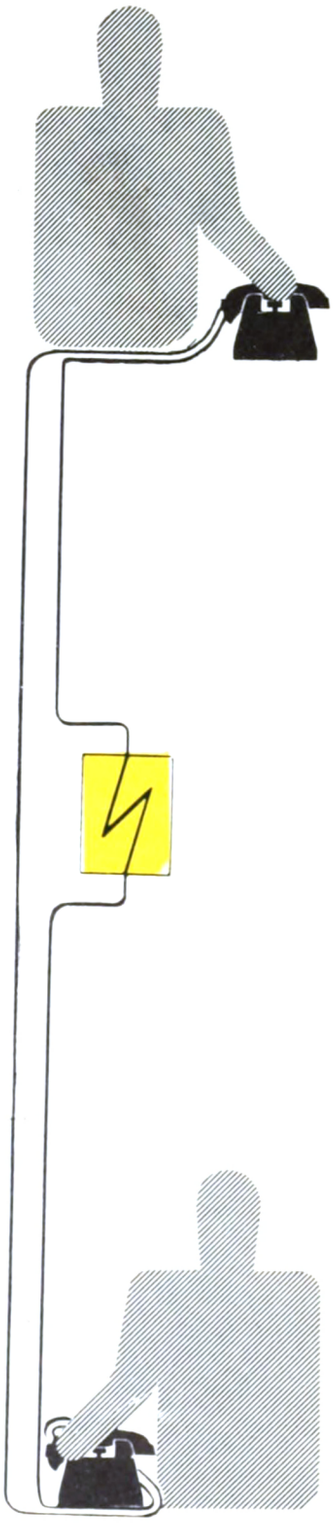
In the telephone mouthpiece there is a thin metal disc, and behind it are particles of carbon. The current, which flows through the disc to the wire inside the telephone, must pass through those particles, and it can do so only where they are squeezed together to form continuous paths. When you lift the receiver, but before you speak, the disc rests lightly on the particles; only a few are squeezed together and only a medium current can flow. When you speak, the disc vibrates. As it presses downwards, more particles are squeezed together and a stronger current flows. As it lifts, some separate again and the current weakens.



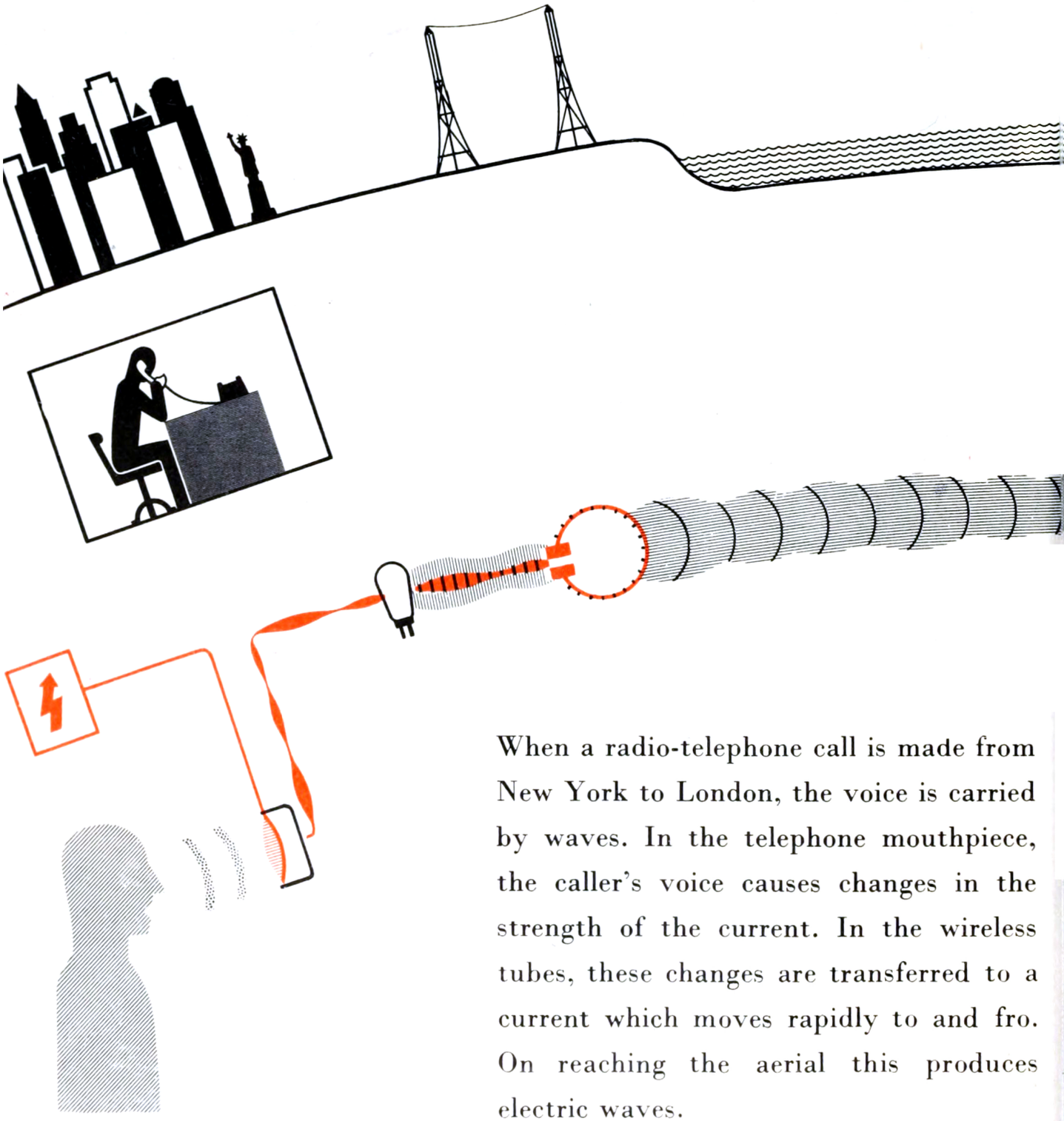


Look at the bottom of page 22 and see what happens in the ear-piece. In it there is another metal disc. While a medium current flows, the electro-magnet is just strong enough to make it curve slightly inwards. When a stronger current flows the magnet becomes stronger and pulls the disc farther inwards; when a weak current flows the magnet weakens and the disc becomes straight. As the current rapidly changes strength, the disc vibrates, and the movement produces waves in the air like the sound waves which enter the mouthpiece.

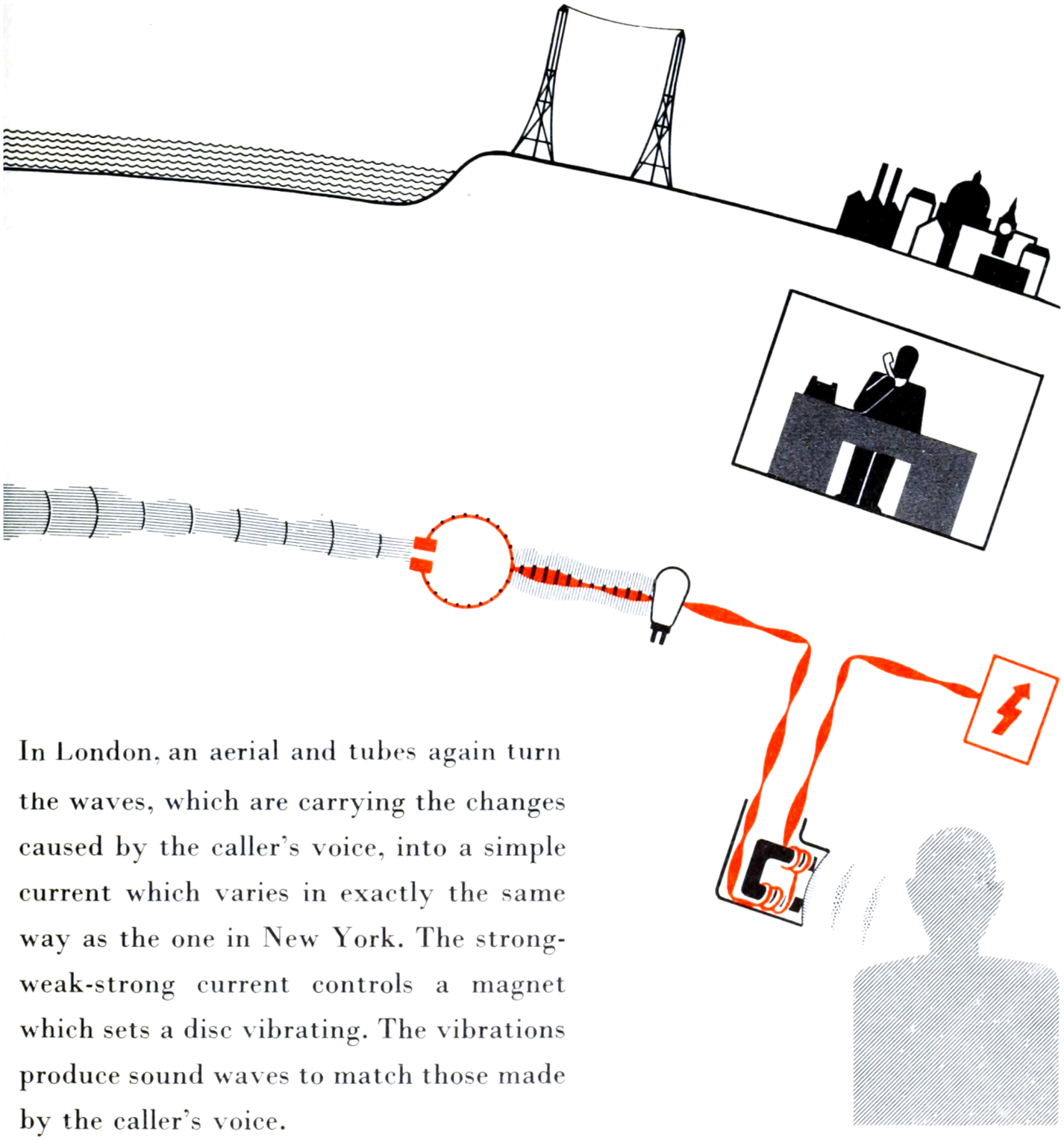
In the picture on the left, the strong-weak-strong current passing through the wire is shown like a string of uneven beads. When you stop speaking and replace the receiver, no current flows.



Speaking Across the World

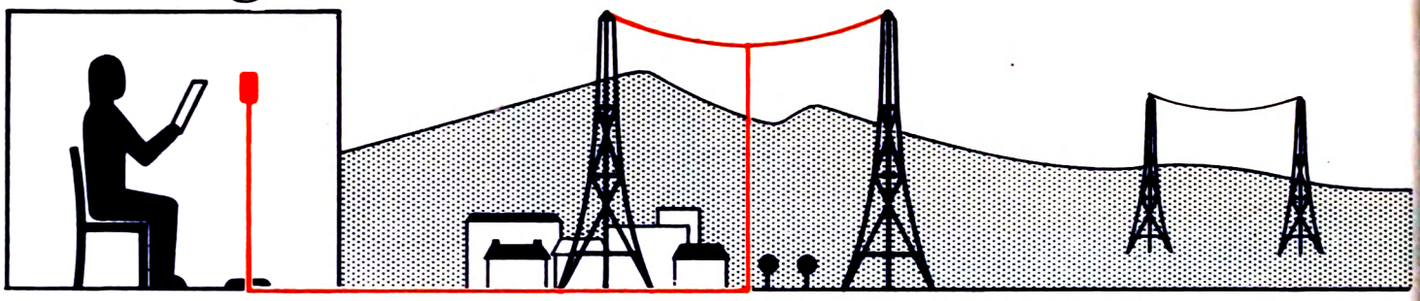


When a radio-telephone call is made from New York to London, the voice is carried by waves. In the telephone mouthpiece, the caller's voice causes changes in the strength of the current. In the wireless tubes, these changes are transferred to a current which moves rapidly to and fro. On reaching the aerial this produces electric waves.

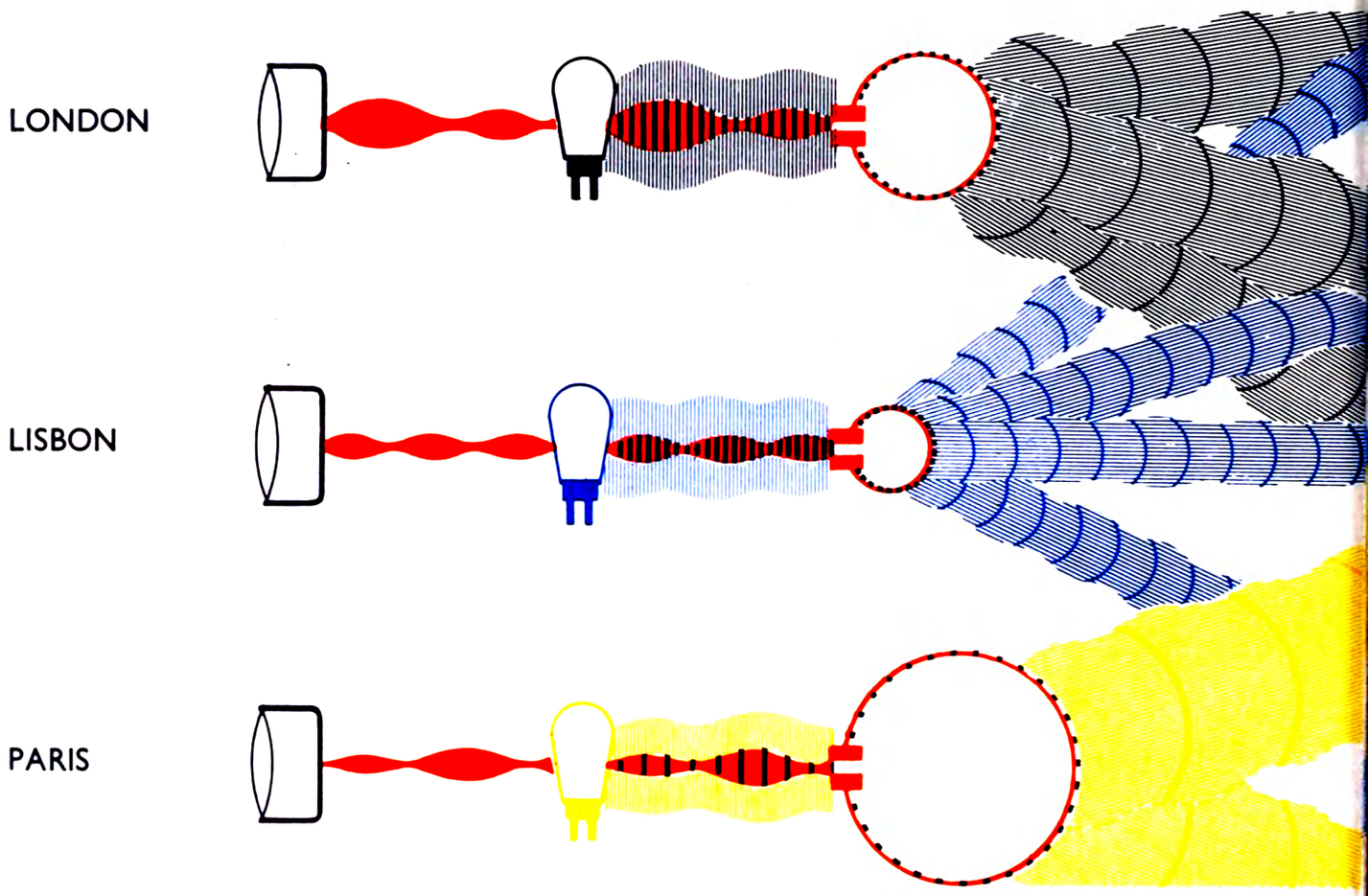


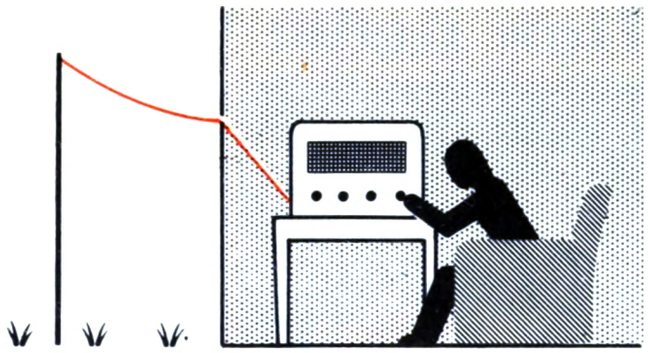
In London, an aerial and tubes again turn the waves, which are carrying the changes caused by the caller's voice, into a simple current which varies in exactly the same way as the one in New York. The strong-weak-strong current controls a magnet which sets a disc vibrating. The vibrations produce sound waves to match those made by the caller's voice.

Picking Out the Voice You Want to Hear

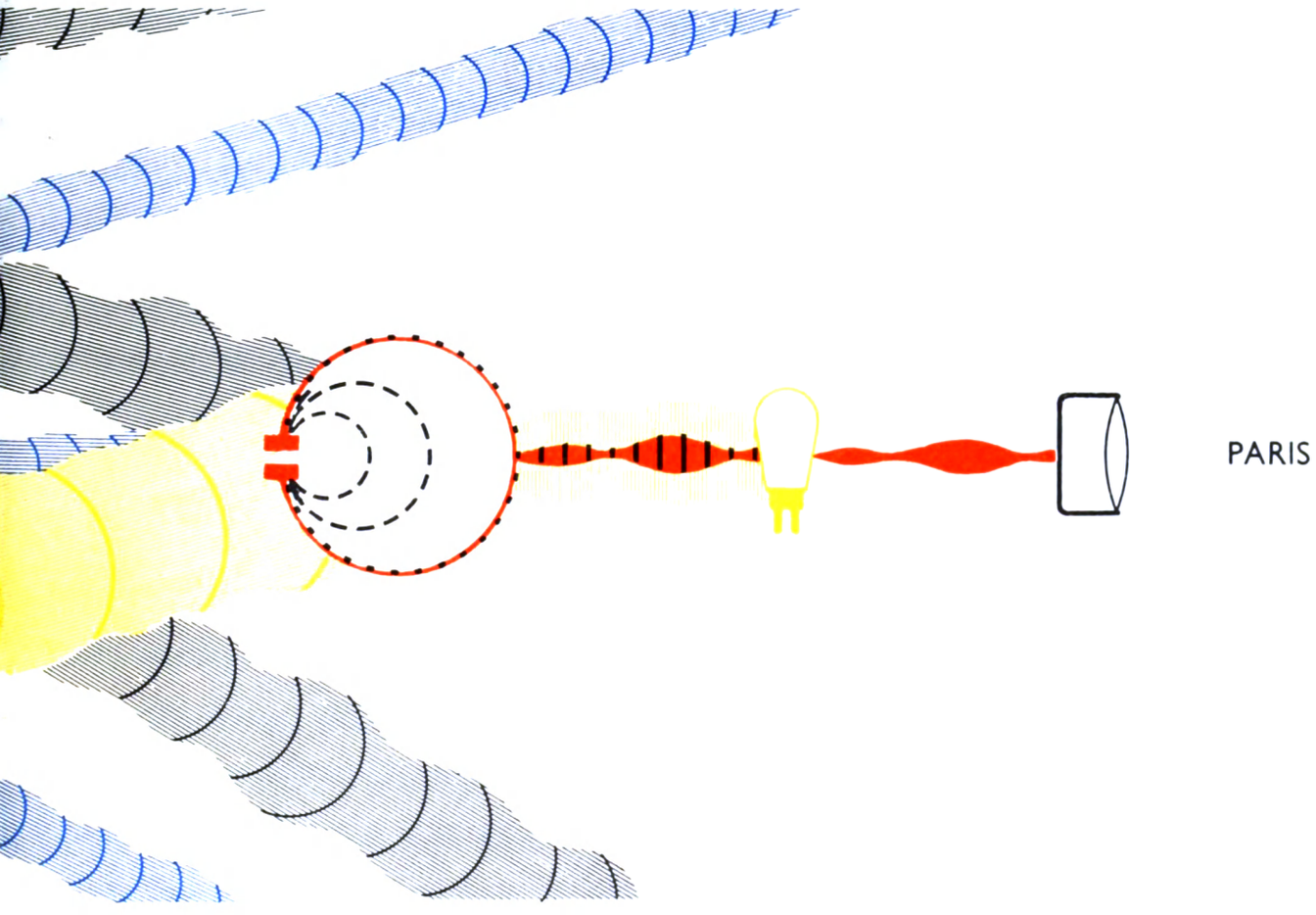


Of all the voices being broadcast, how can we choose just one to listen to? Each station fixes its sending set to send out waves of a chosen length. The stations all choose different wave-lengths. These waves travel in all directions; some reach your aerial.

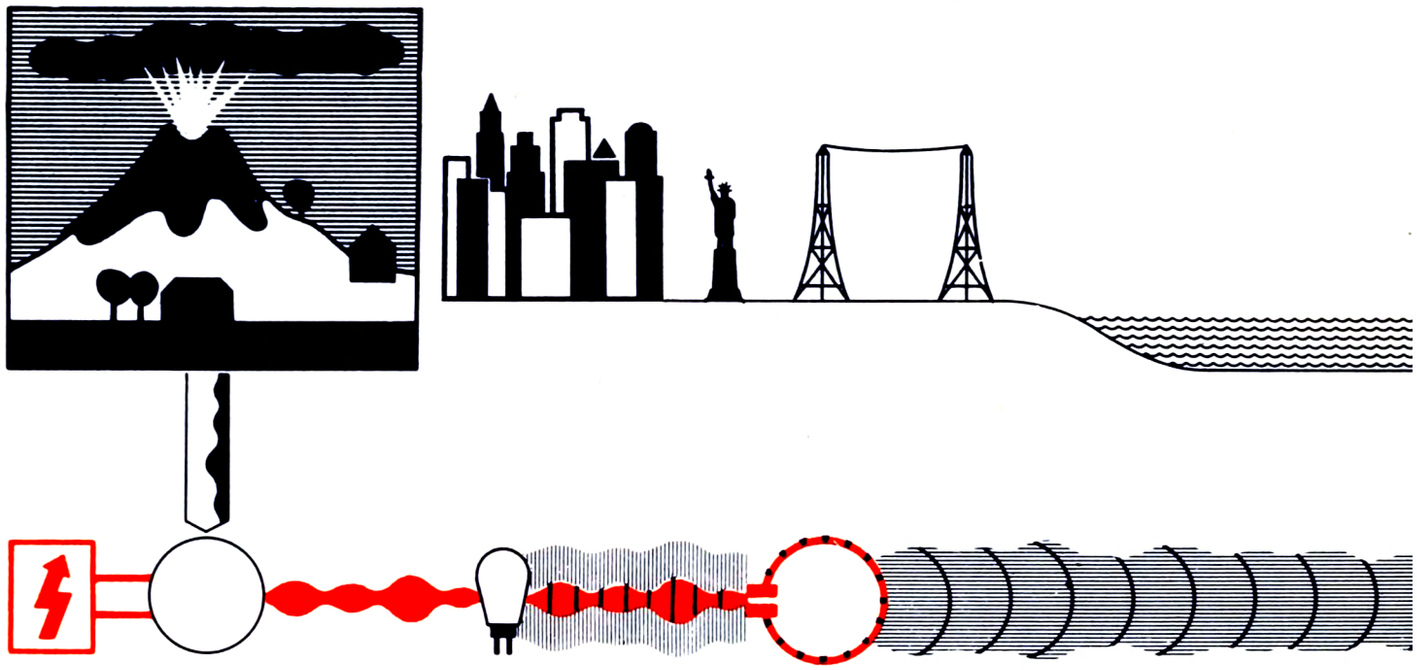


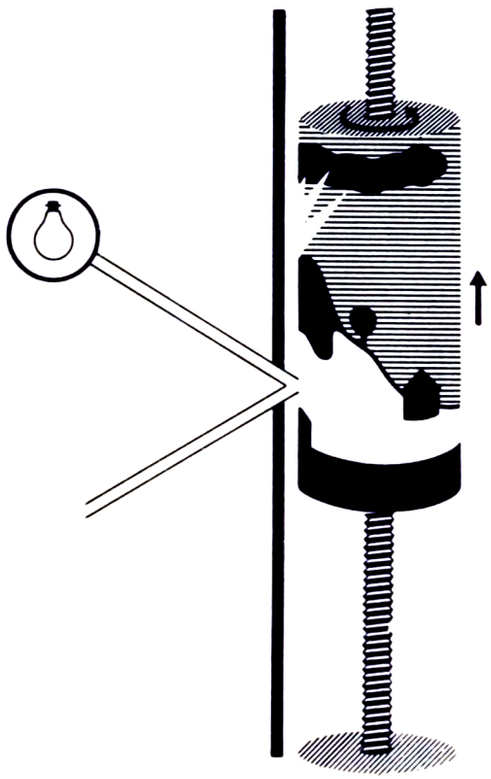


To pick out the station to which you want to listen, you fix your receiving set so that it collects most strongly the waves of the length sent out by that station. This is called "tuning" your set to that wave-length. This man has tuned his set to the wave-length of the Paris station.

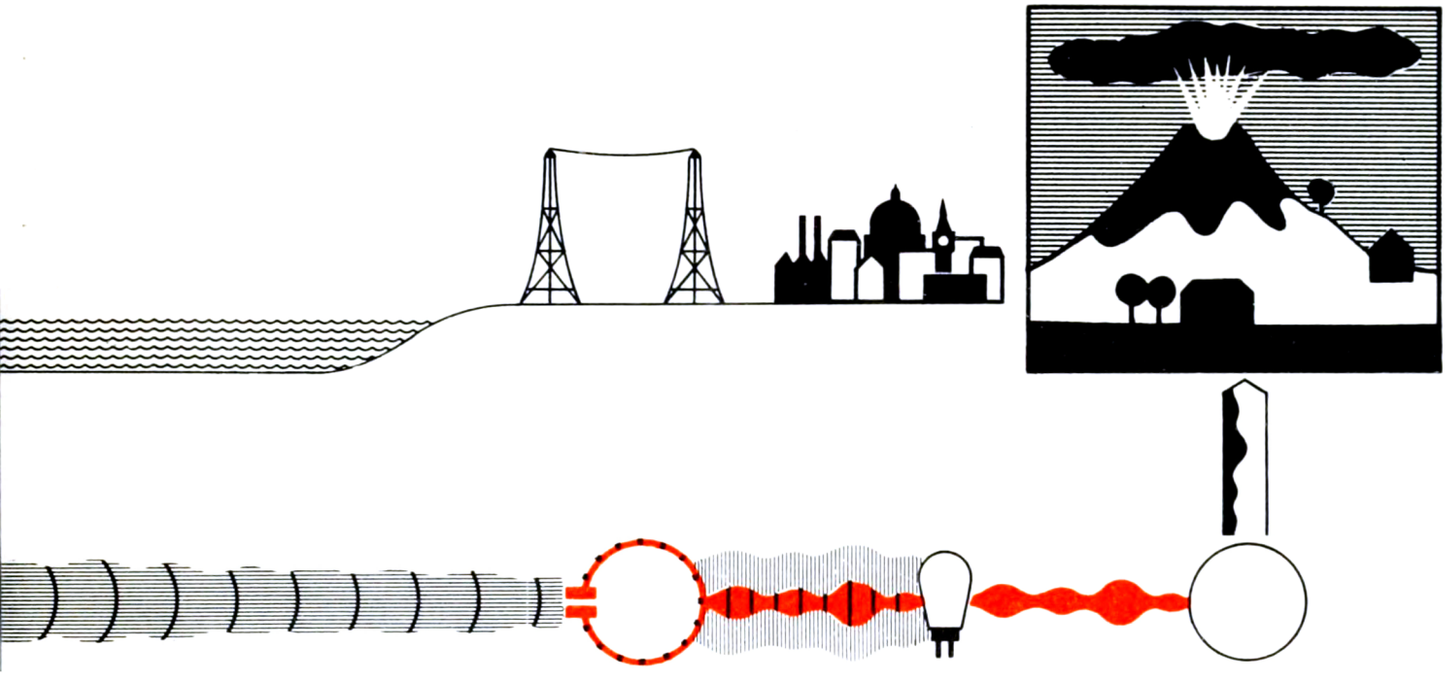


How Radio Waves Can Carry a Picture



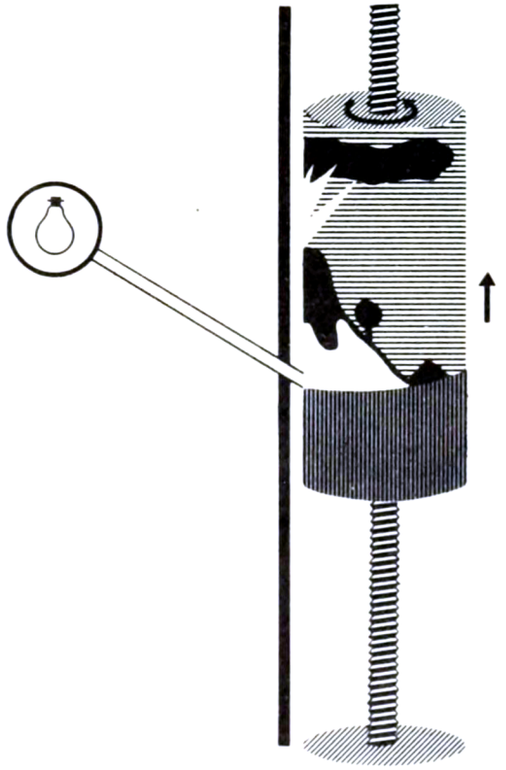


Pictures, as well as voices, can be sent round the world in a flash. At the sending station, the picture is fitted round a cylinder which revolves on a screw. As it turns it rises, and so a very small fixed beam of light shining on the picture gradually passes over the whole surface. More light is reflected back from bright parts than from dark ones, and the changing ray of reflected light causes changes in the strength of an electric current. These strong-weak-strong changes are made to occur in a current moving rapidly to and

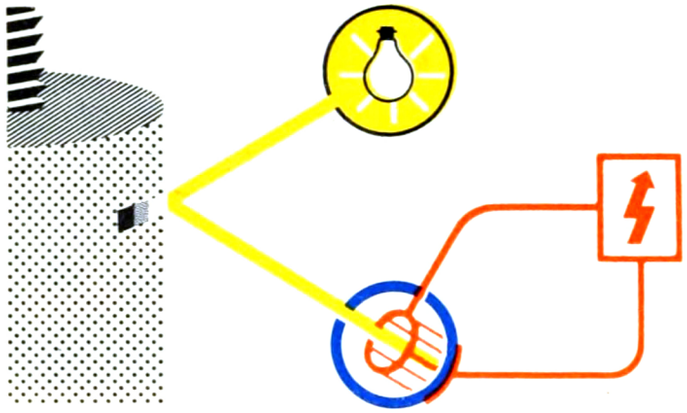


fro in an aerial. This sends out waves in which the changes also occur.

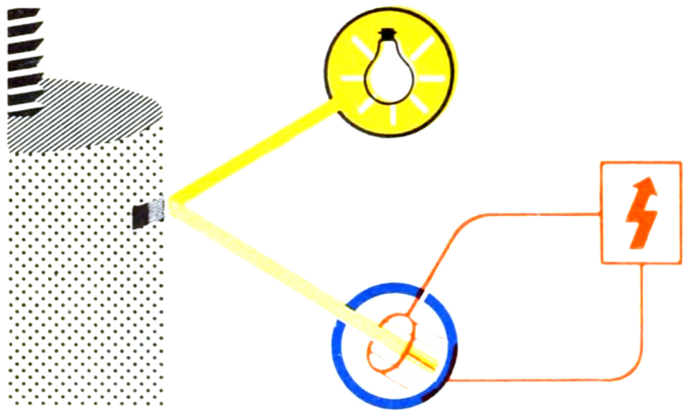
At the receiving station the changes in the waves are turned back into changes in a simple current. These affect a beam of light, as we shall see when we turn over to the next page. The beam falls on a cylinder which turns and rises in the same way and which is covered with a special paper. When the beam is strong the paper turns white, when it is weak the paper remains dark, and slowly, as the cylinder turns, a copy of the picture appears.



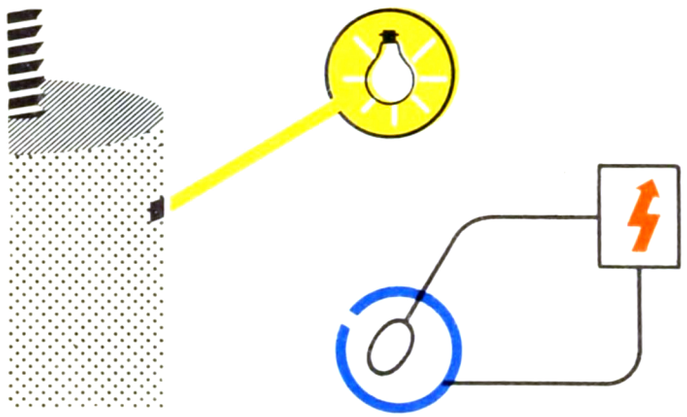
Picture into Current, Current into Picture



The secret of sending a picture by radio is a wonderful cell which allows an electric current to pass through it only when a light shines into it. When the beam from the lamp shines on a white part of the picture, almost all the light is reflected back into the cell, and a strong current flows.

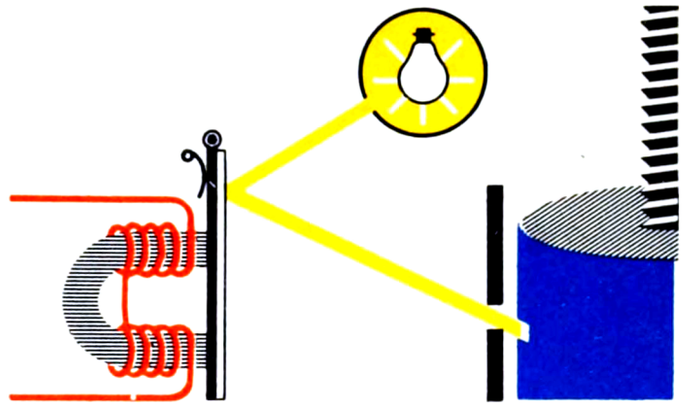


The cylinder turns and the beam shines on a greyish part of the picture. Now only part of the light is reflected into the cell, and the current passing through it becomes weaker.

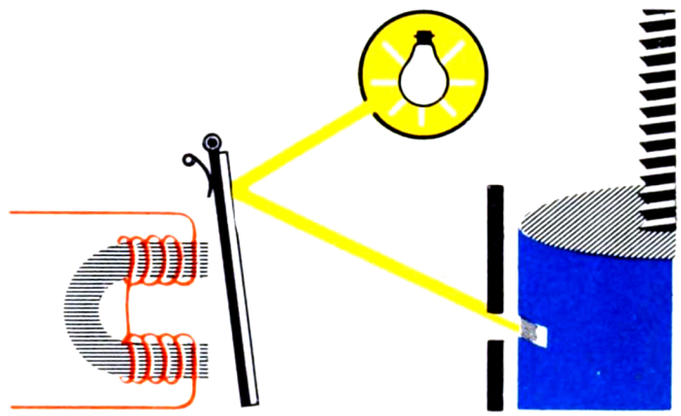


When the beam falls on to a black part of the picture no light is reflected back. Without light the cell will carry no electricity, so the current stops.

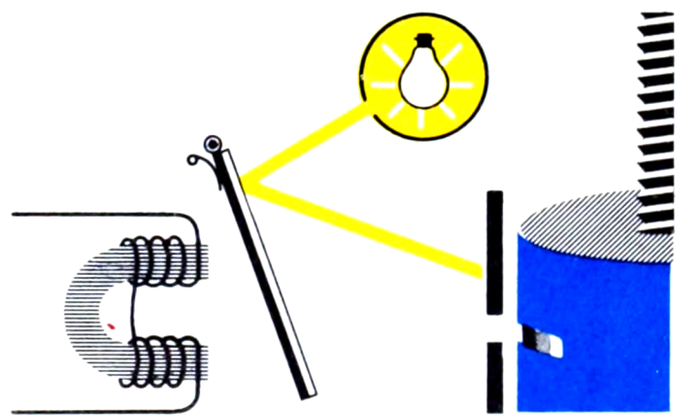
At the receiving end, the changing current makes a magnet stronger when the current is strong, weaker when it is weak. While a strong current flows, the magnet holds a mirror (with a metal back) upright. All the light reflected from it passes through a hole in a screen and falls on to the cylinder.



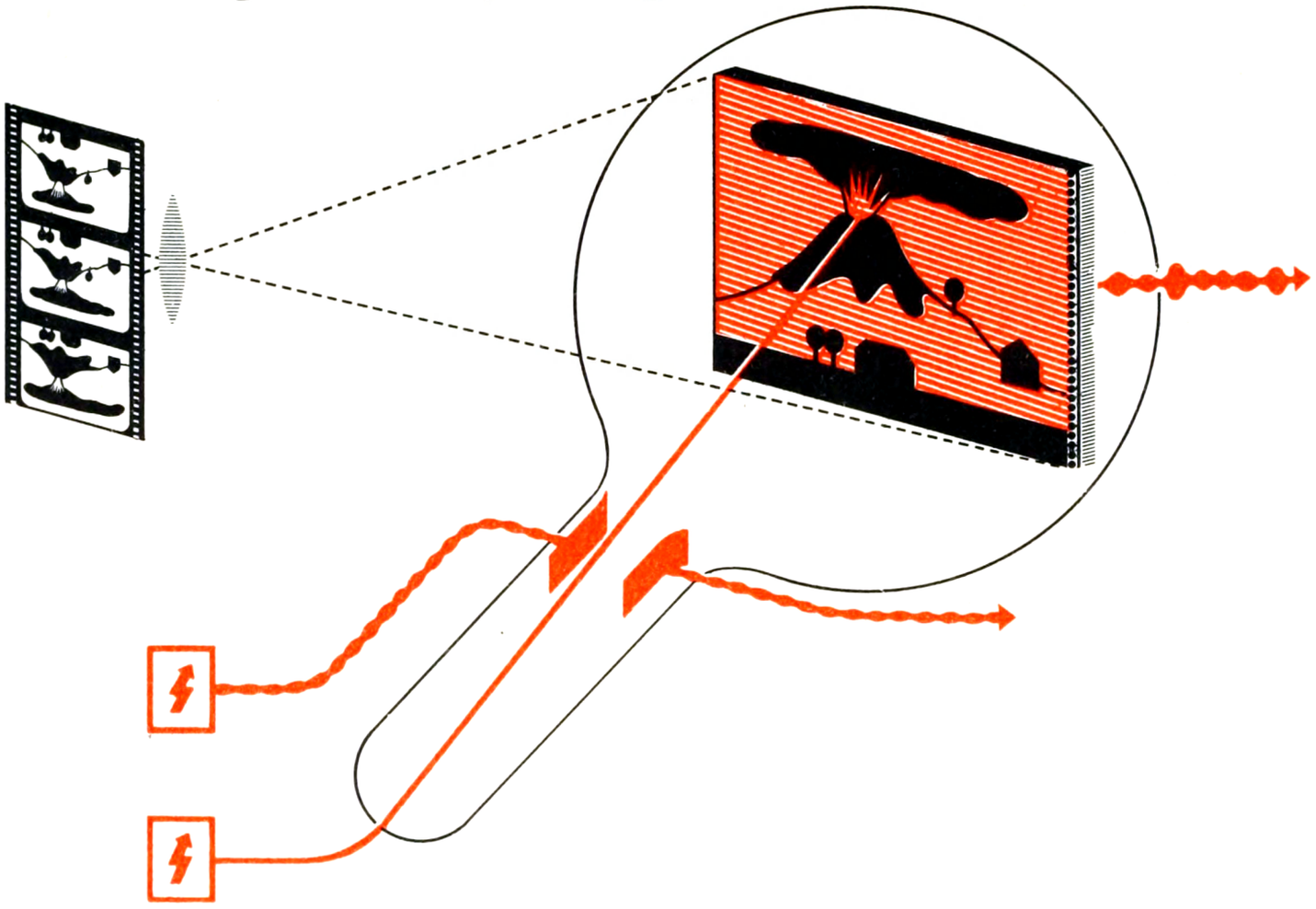
When a weaker current flows, the magnet becomes weaker, and a spring tilts the mirror away from it. Now only part of the light reflected from the mirror can pass through the hole.



When no current flows, the magnet loses all its pull. The spring tilts the mirror still farther, and no light passes through the hole.



Sending Thirty Separate Pictures Every

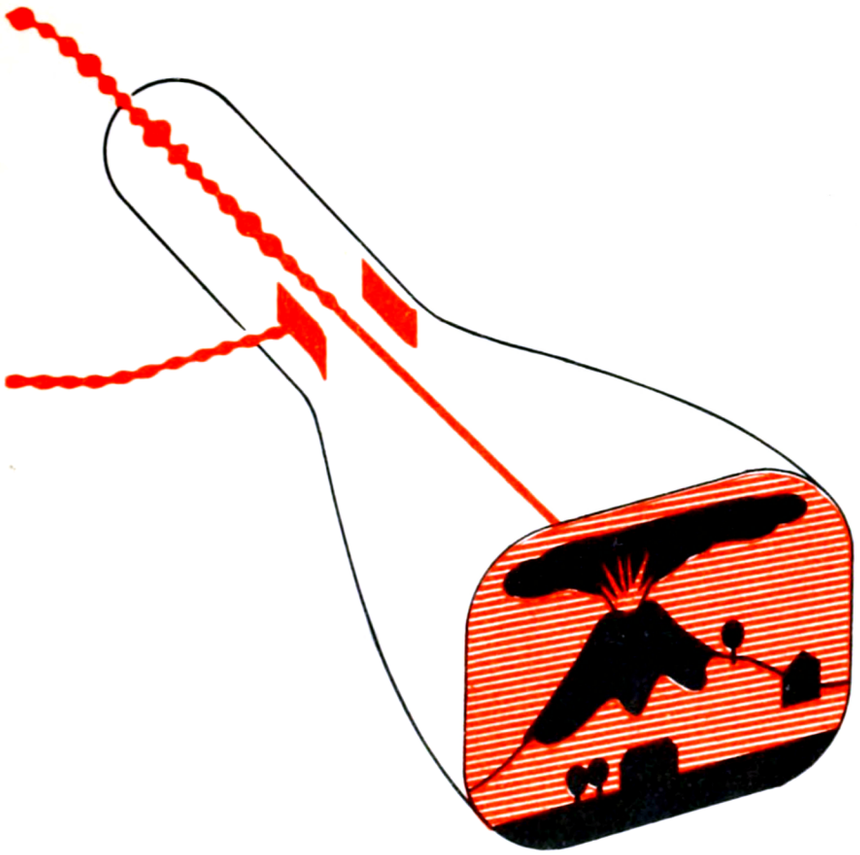


To show moving pictures on a television screen, the station must send out twenty-four, twenty-five or thirty separate pictures every second.

One by one they flash on to a plate inside a large bulb. At the neck of the bulb, a powerful current causes a ray to sweep rapidly to and fro across the plate, from top to bottom. This ray is made up of millions of particles called electrons, each much smaller than an atom. Where the ray strikes a bright part of the picture, a strong current flows from the plate; where it strikes a dark part, a weaker current flows. (We shall see this more clearly when we turn over.)

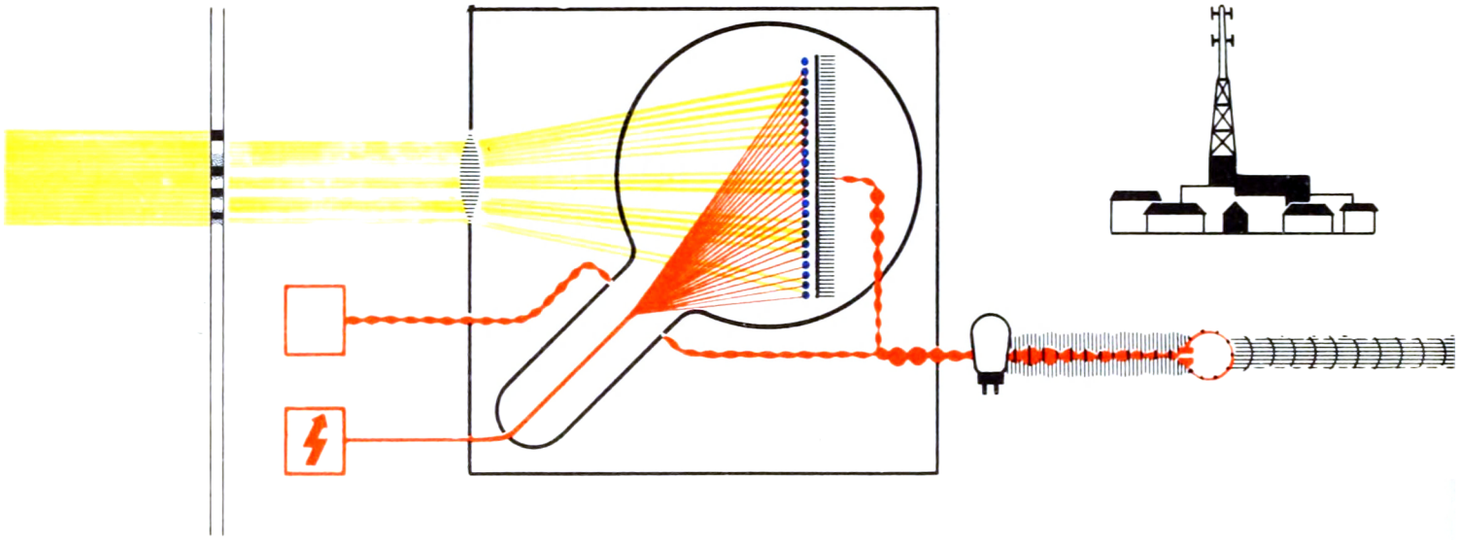
Second

This strong-weak-strong current is carried by waves to the television receiver, where it causes another electron ray to carry many electrons when the current is strong and few when the current is weak. This ray sweeps line by line over the back of the screen at which you look, in time with the ray at the sending station.

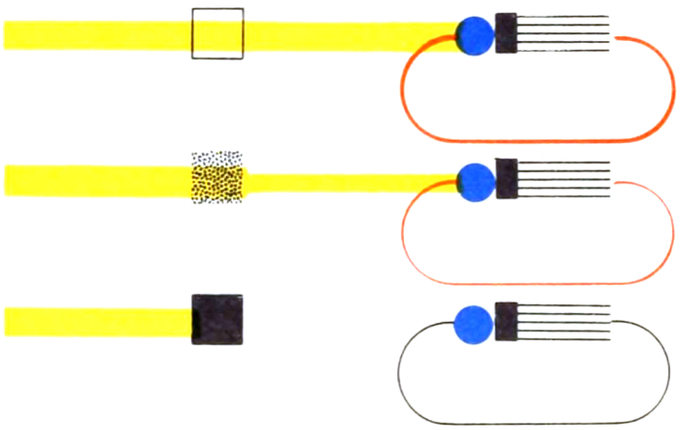


Where many electrons reach the screen it glows brightly, where few reach it, it is dark. The ray moves so fast that you seem to see the picture all at the same moment.

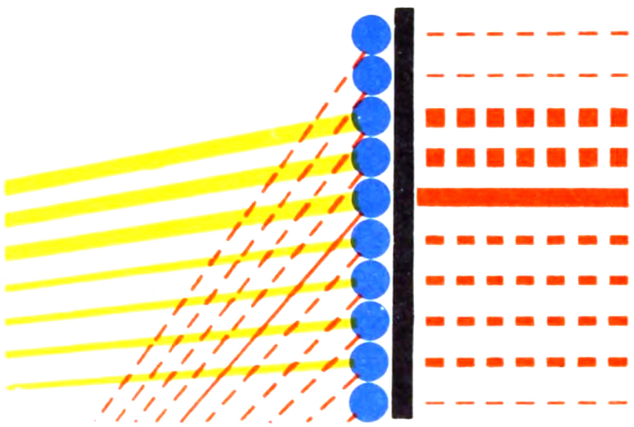
The Ray that Paints the Television Picture



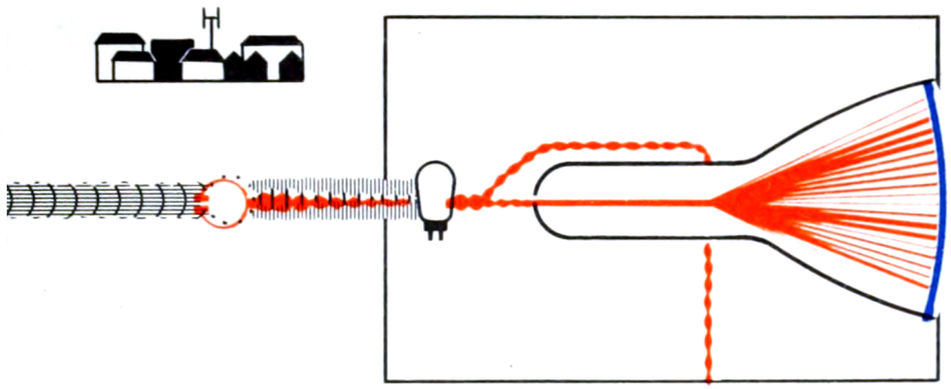
The surface of the plate on which the pictures are thrown is made up of many particles (shown in blue). A strong light falls on some, a weak one on others. Moving at terrific speed, the electron ray strikes each particle, one by one.



The strong light falls when the beam passes through a white part of the picture, the weaker light when it passes through darker parts.



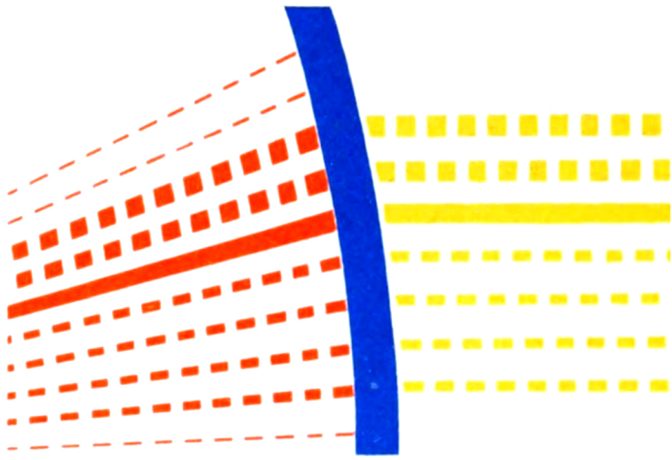
When the electron ray falls on a strongly-lighted particle, a strong current flows; when on a dimly-lighted particle, a weak current flows.



The strong-weak-strong simple current is changed to a to-and-fro current and then to waves. At the receiving set it is changed back into a strong-weak-strong simple current which causes a sweeping electron ray to be sometimes strong and sometimes weak in turn.

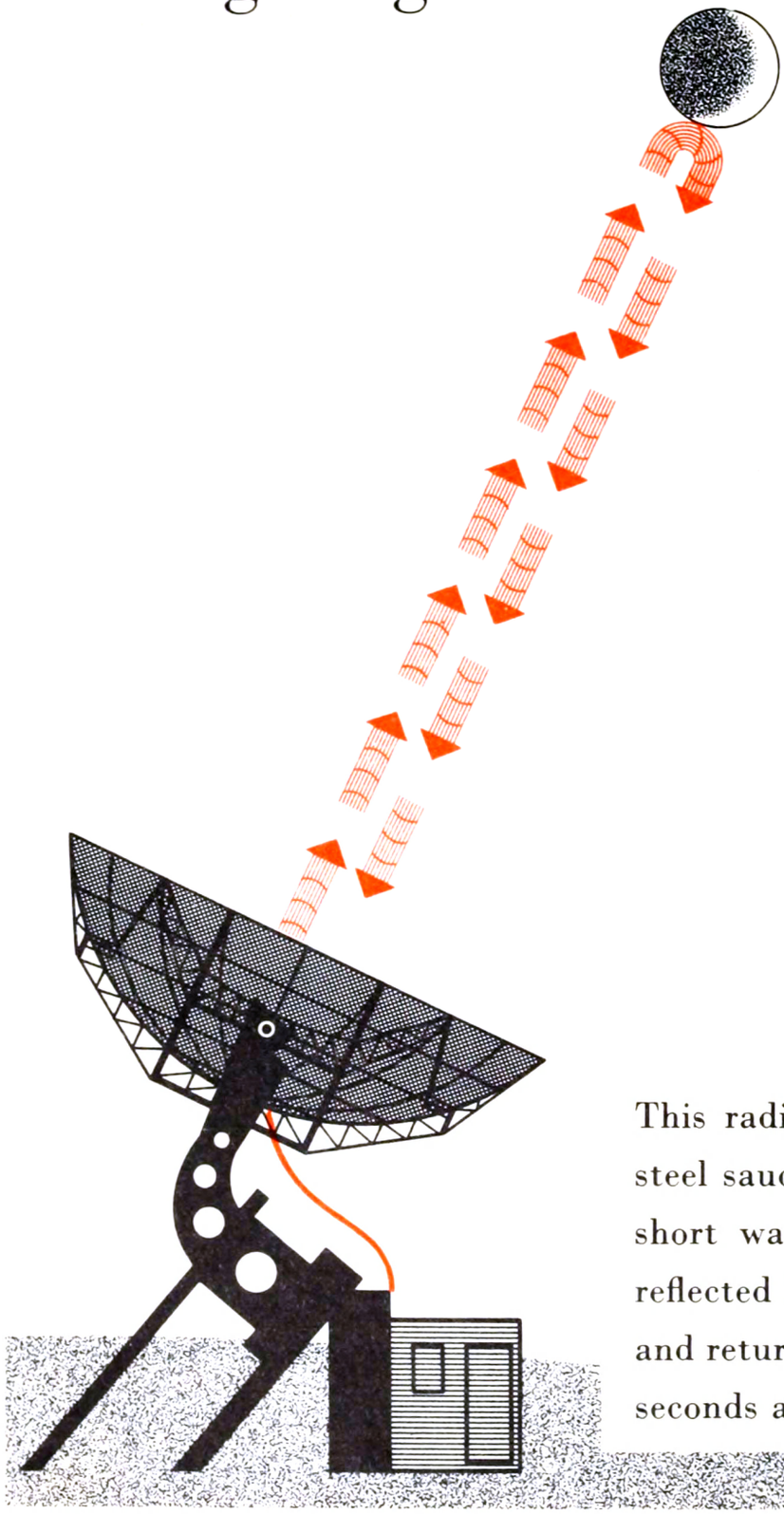
The strong-weak-strong ray of electrons sweeps across the back of the viewing screen (shown in blue). The screen is coated with a chemical which glows brightly where the ray strikes it strongly, dimly where the ray strikes it weakly.

So more light comes from some parts of the screen than from others. The bright and dull patches seem to our eyes to make up the picture itself.



Here we see what is happening on both sides of the viewing screen. Where most electrons strike the back the light shines strongest from the front.

Sending a Signal to the Moon



This radio telescope, shaped like a giant steel saucer, sends a radar signal by very short waves to the moon. The signal is reflected back by the surface of the moon and returns to the telescope two and a half seconds after it started.